RADAR 101

Everything field grades need to know about the radar but don’t !

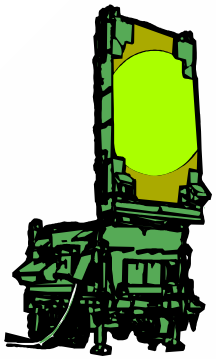
AN/TPQ 36 FIREFINDER RADAR

- The primary mission is to locate enemy mortar and shorter range artillery firing positions.

- It is designed to locate **shorter-range, high-angle, low-velocity** indirect firing systems. However, it will locate high-velocity artillery and rockets within its capabilities.

- Normally attached to the direct support (DS) artillery battalion that it supports for operational control and logistics.

AN/TPQ-37 Firefinder Radar



- The primary mission is to locate enemy artillery and rocket, firing positions.

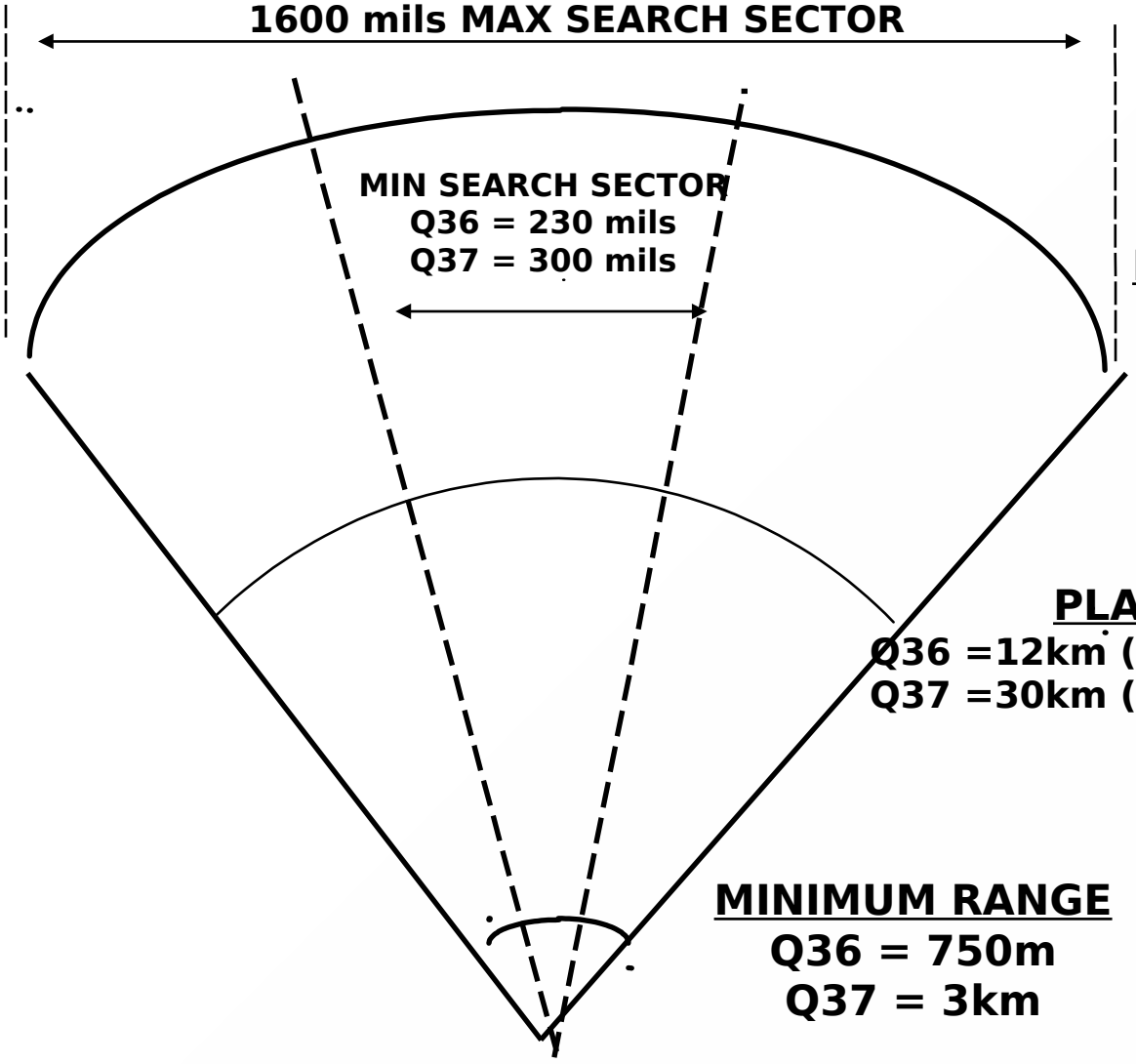
- It is designed to locate **longer-range, low-angle, higher-velocity** indirect firing systems. However, it will locate shorter-range, high-angle, low-velocity indirect firing systems within its capabilities.

- Normally attached to the general support (GS) artillery battalion that it supports or remains under control of the Division Artillery (Divarty) or an FA Bde headquarters.

HOSTILE MODE OPERATIONS

TRACKING CAPABILITIES & LIMITATIONS

SEARCH SECTOR



MAXIMUM RANGE
Q36 = 24km
Q37 = 50km

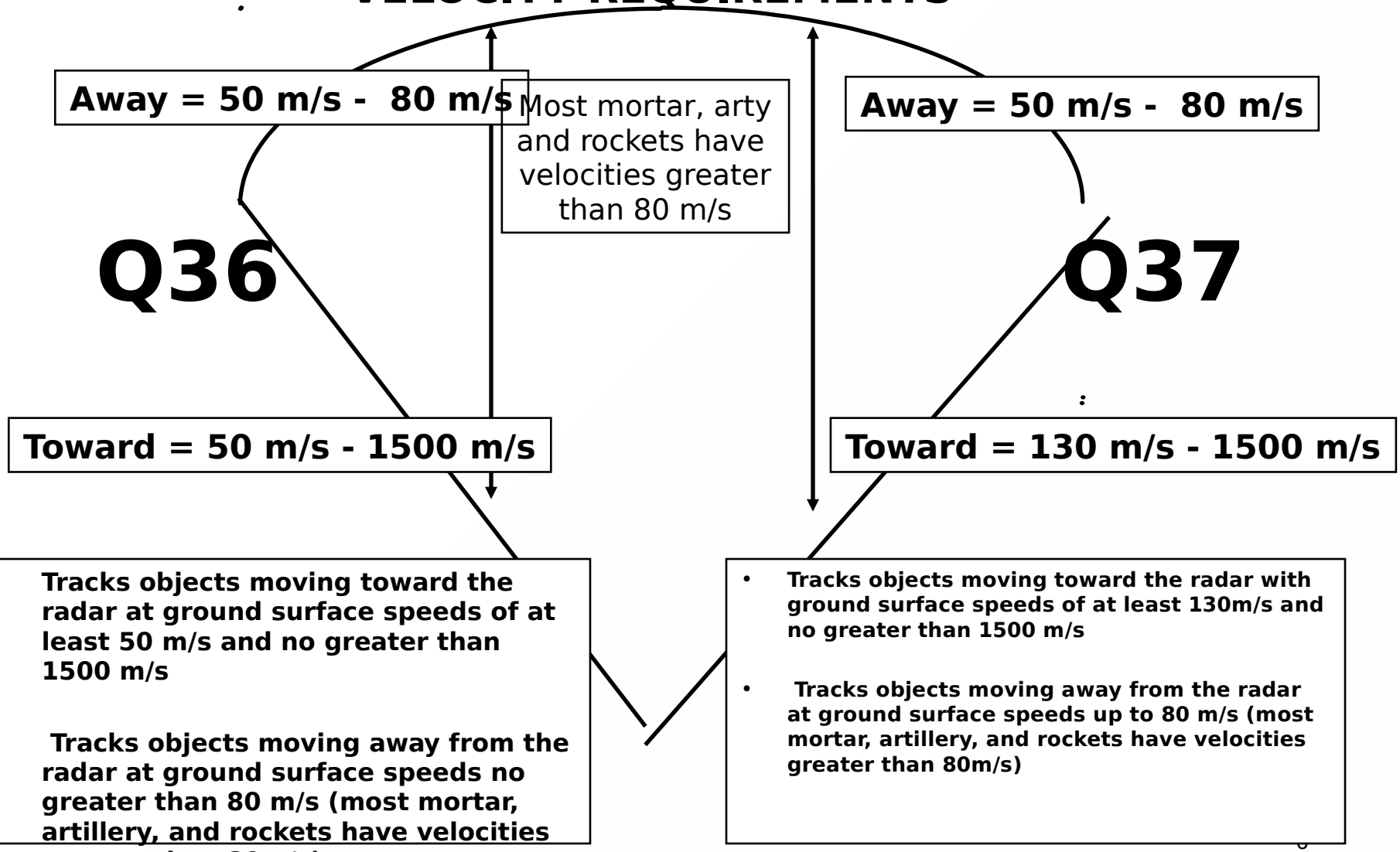
PLANNING RANGE
Q36 =12km (Arty & Mtrs) 24km (Rkts)
Q37 =30km (Arty & Mtrs) 50km (Rkts)

MINIMUM RANGE
Q36 = 750m
Q37 = 3km

Note: must have min of 900m difference between min and max distance

TRACKING CAPABILITIES & LIMITATIONS

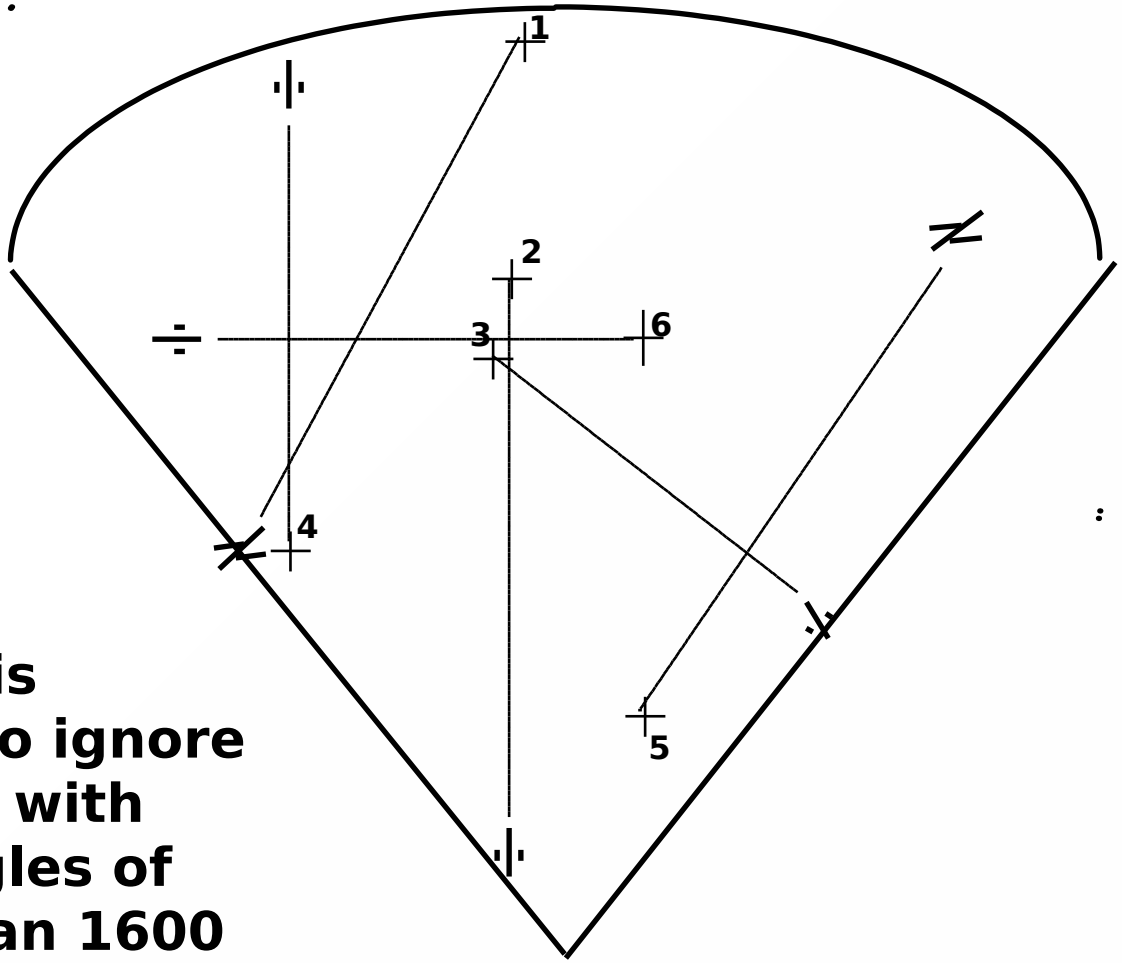
VELOCITY REQUIREMENTS


Away = 50 m/s - 80 m/s
Most mortar, arty and rockets have velocities greater than 80 m/s
Away = 50 m/s - 80 m/s
Q36
Q37
Toward = 50 m/s - 1500 m/s
Toward = 130 m/s - 1500 m/s
• Tracks objects moving toward the radar at ground surface speeds of at least 50 m/s and no greater than 1500 m/s
• Tracks objects moving away from the radar at ground surface speeds no greater than 80 m/s (most mortar, artillery, and rockets have velocities greater than 80m/s)
• Tracks objects moving toward the radar with ground surface speeds of at least 130m/s and no greater than 1500 m/s
• Tracks objects moving away from the radar at ground surface speeds up to 80 m/s (most mortar, artillery, and rockets have velocities greater than 80m/s)

TRACKING CAPABILITIES & LIMITATIONS

ASPECT ANGLE

Aspect Angle: The angle between the radar antenna and the target path of the object .



Detected?

1 - No

2 - No

3 - No

4 - Yes

5 - Yes

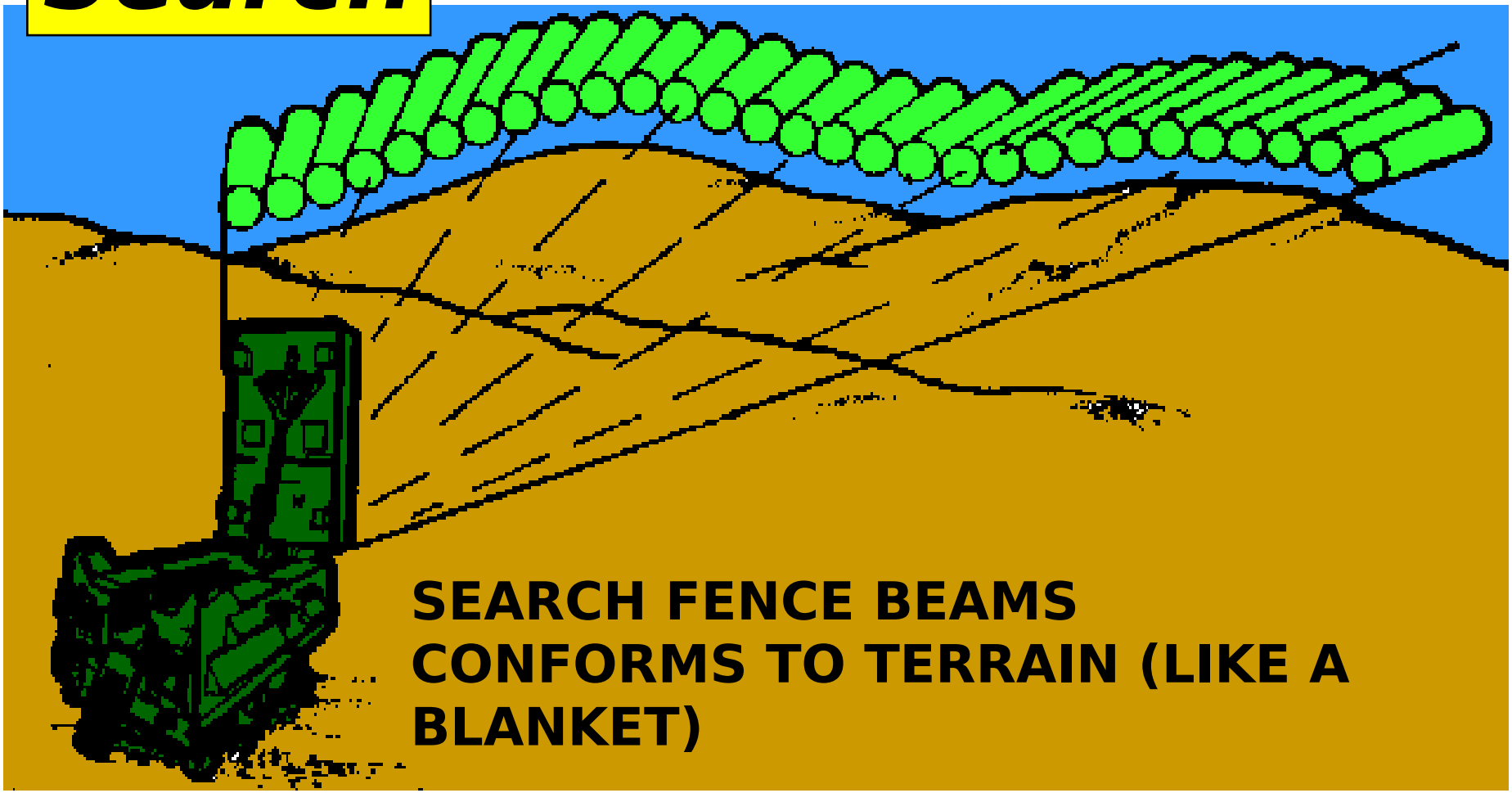
6 - 50/50

The radar is <u>designed</u> to ignore detections with aspect angles of greater than 1600 mils (its not

HOW THE RADAR WORKS

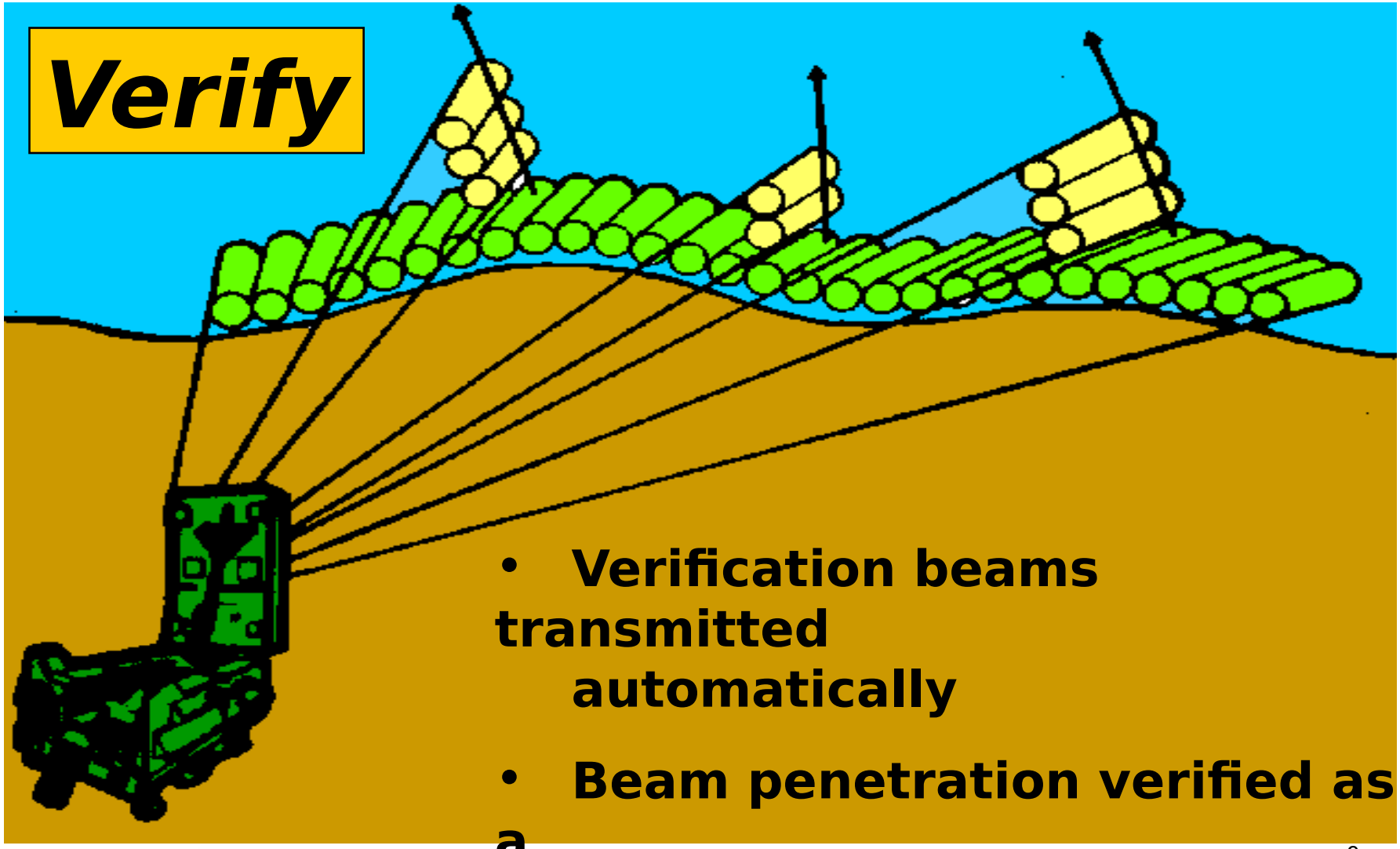
Search Fence Established

Search



HOW THE RADAR WORKS

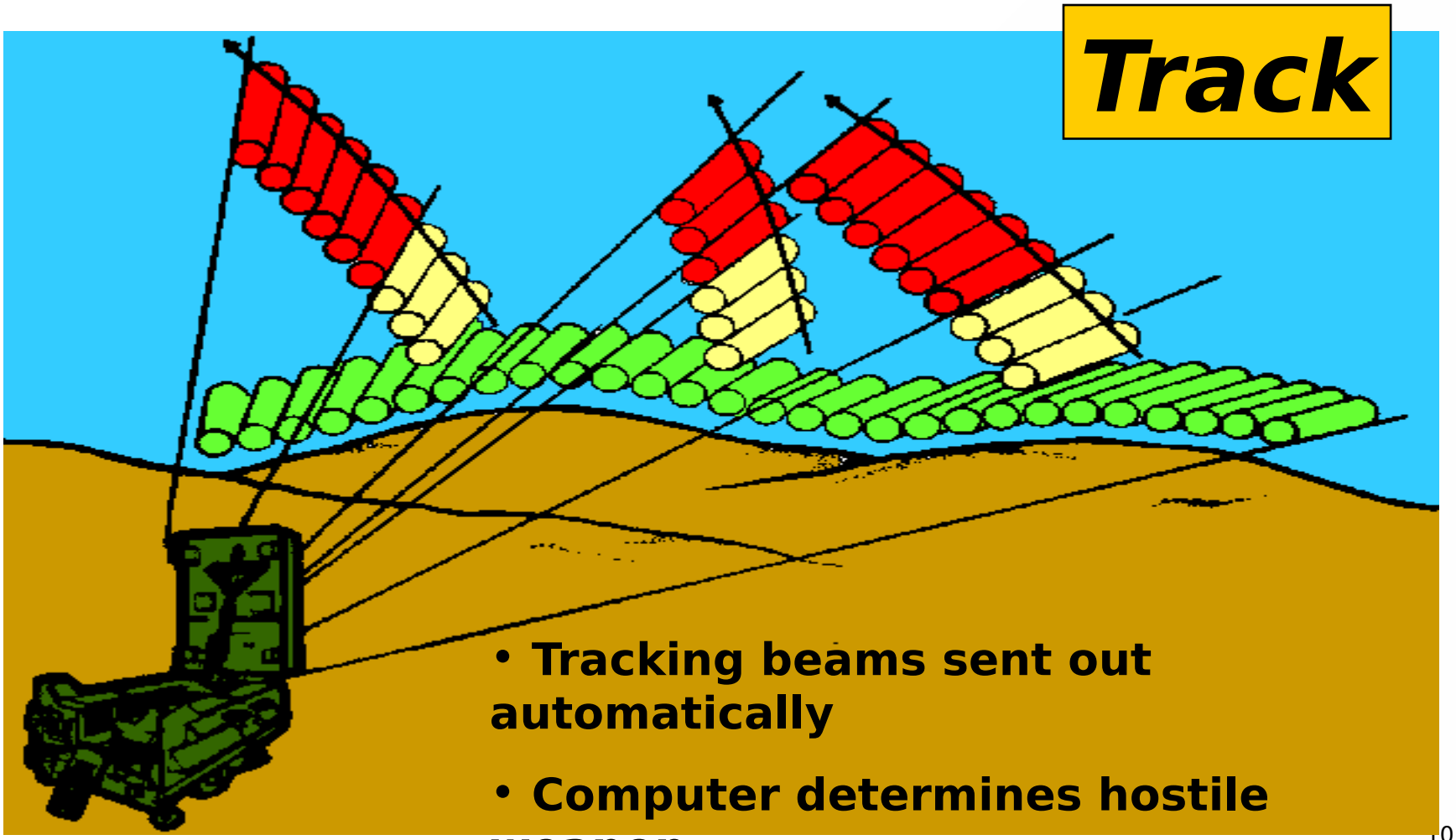
Search Fence Penetrated



- Verification beams transmitted automatically
- Beam penetration verified as a projectile

HOW THE RADAR WORKS

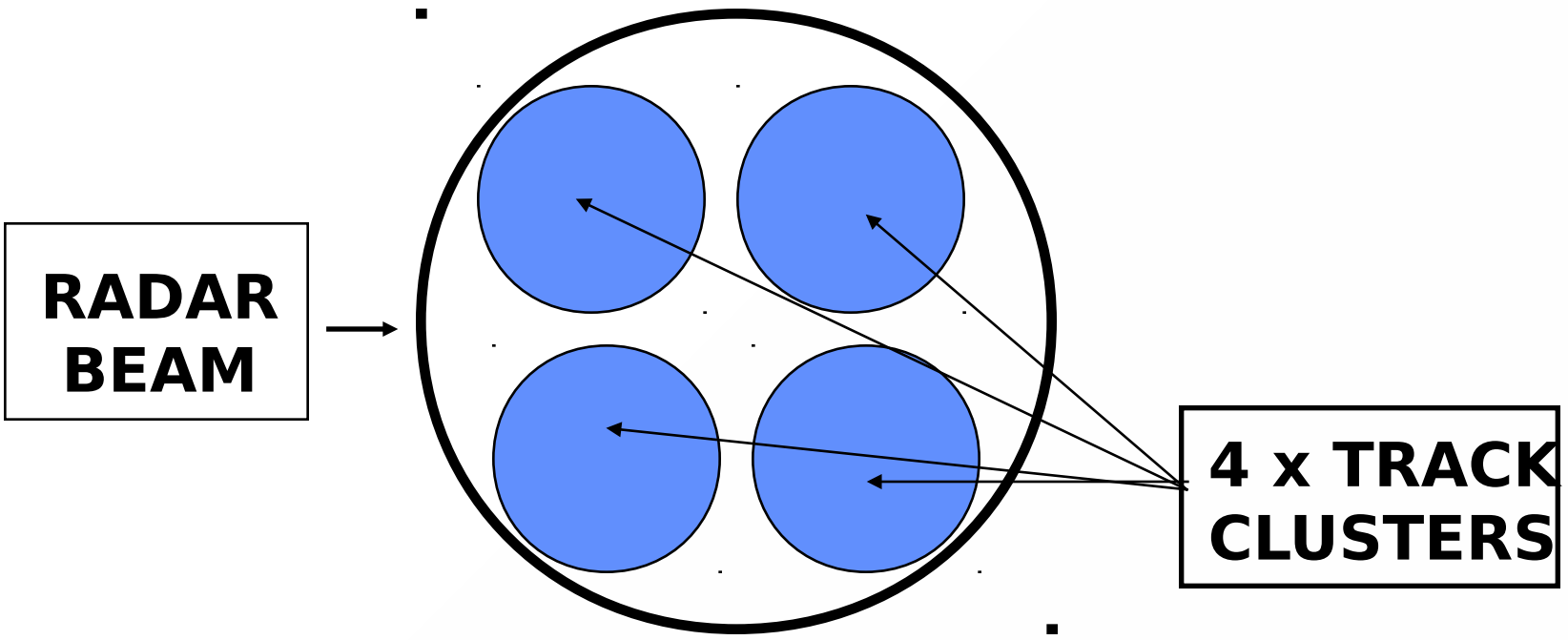
Projectile is Tracked



HOSTILE MODE TRACKING PARAMETERS

- Radar only detects objects on their ascending trajectory.
- The object must be big enough to create a radar return in order for the radar to “see” the object.
- The speed of the object must be within the velocity parameters of the radar in order for the radar to “see” the object.
- The radar must determine that the object’s trajectory displays ballistic characteristics, or it is rejected.
- Radar must track the object long enough to achieve a solution
  - Q36: 3 - 5 seconds
  - Q37: 5 - 8 seconds

RADAR BEAM CROSS-SECTION

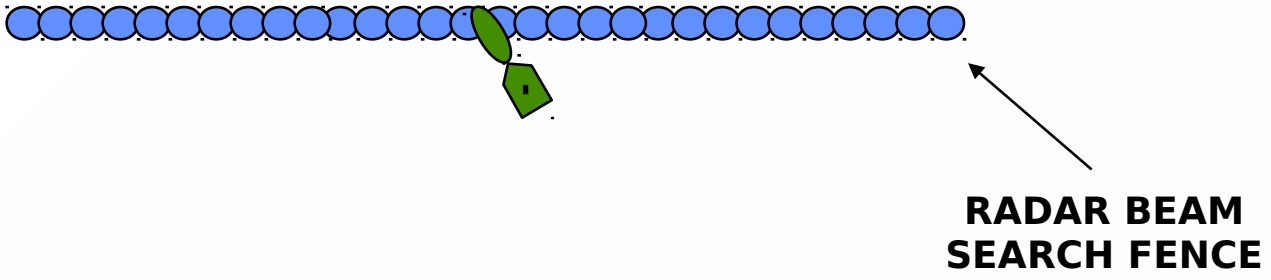


HOSTILE MODE TRACKING PROCESS

1. **Object breaks the search fence beam**

2. **Radar determines the object's:**

   - **Speed**
   - **Elevation**
   - **Range**
   - **Azimuth**



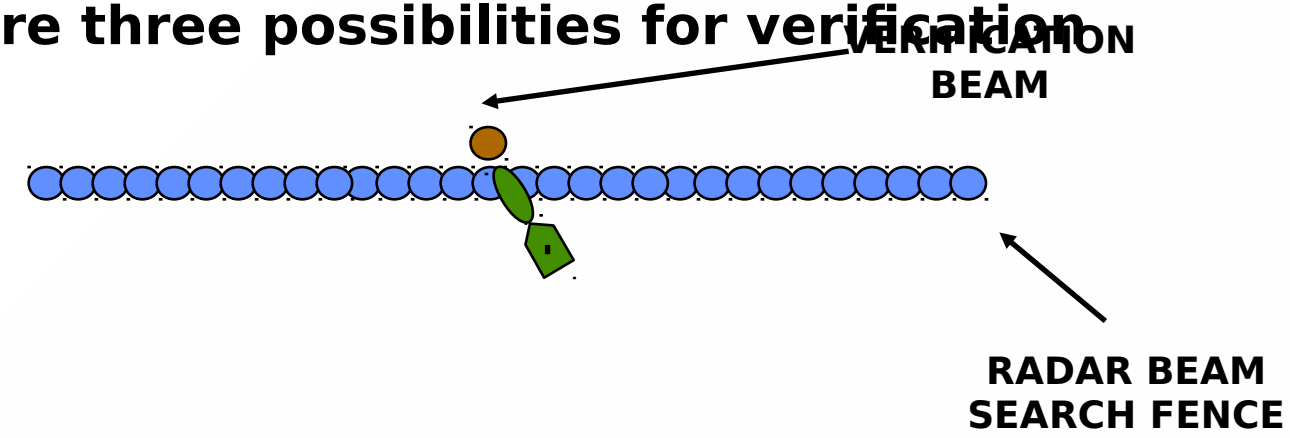
HOSTILE MODE TRACKING PROCESS

1. Radar predicts the objects next location and sends out verification beams to determine if the object has ballistic characteristics.

2. Object must successfully pass 15 discriminate tests for the computer to verify that it has a ballistic trajectory.

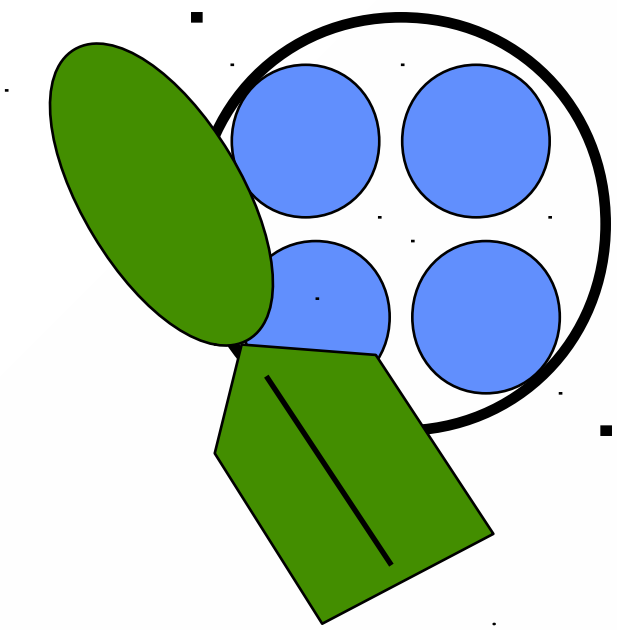
3. There are three possibilities for verification beam:

- **Hit**
- **Miss**
- **Plot**



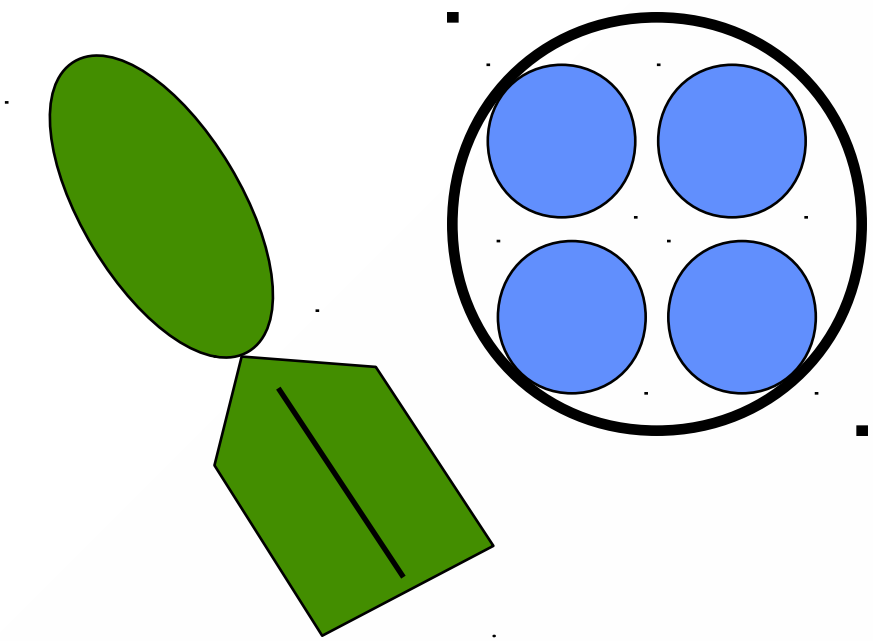
HIT

- **When at least one track cluster, but not all, detect the object**
- **Insufficient data is collected to constitute a plot**



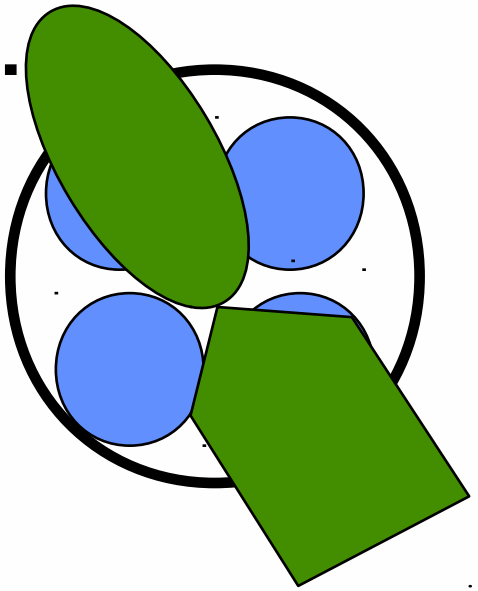
MISS

When none of the track clusters are stuck by the object



PLOT

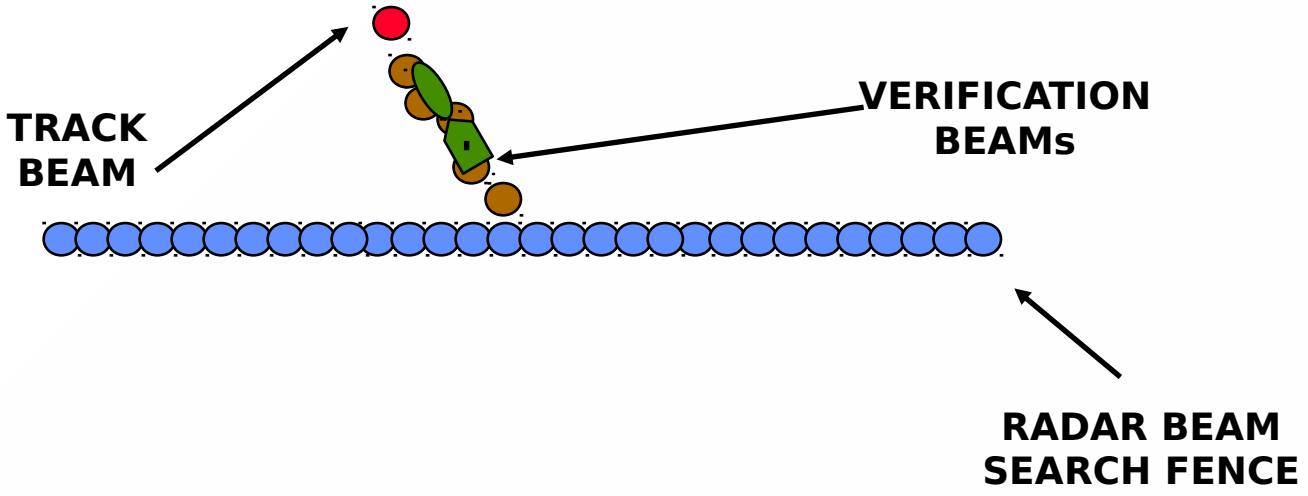
- **All four track clusters detect the object**
- **The detected range of the projectile is within 75 meters of the predicted range**
- **The detected azimuth is within 20 mils of the predicted azimuth (Q36), 15 MILS (Q37)**
- **The detected elevation is within 15 mils of the predicted elevation (Q36), 10 MILS (Q37)**



HOSTILE MODE TRACKING PROCESS

1. If ballistic trajectory is verified, radar sends out a series of tracking beams.

2. Track beams provide the computer information about the objects ballistic arc to mathematically extrapolate a predicted launch and impact point.



TRACK TERMINATION

The radar stops sending out verification beams when:

- **Radar computes a solution to the acquisition.**
- **3 sequential misses happen (Q36), 5 misses for (Q37)**
- **The predicted azimuth of the next track update is outside the left or right limits of the radar's search sector**
- **The predicted elevation of the next track is above or below the radar's min or max search elevation (outside the search box)**

MINIMUM Q36 ACQUISITION REQUIREMENTS

- **<u>3-5 seconds of good tracking time</u>**

- **If tracking is terminated for 3 sequential misses the number of plots required for a solution varies from 6 to 15 based on initial detection range.**

- **If tracking is terminated for other than 3 sequential misses the number of plots required for a solution varies from 3 to 10 based on initial detection range.**

MINIMUM Q37 ACQUISITION REQUIREMENTS

- **<u>5 - 8 seconds of good tracking time</u>**
- **If tracking was terminated for 5 sequential misses:**
  - At ranges less than 30km at least 12 plots are required for a solution.
  - At ranges greater than 30km at least 15 plots are required for a solution.
- **If tracking was terminated for reasons other than 5 sequential misses:**
  - From 3kms - 7kms the minimum plot requirement is 5
  - From 7kms - 16 kms the minimum plot requirement increases at a linear rate from 5 to 12 and then remains constant until 30 kms.
  - At 30 kms the minimum plot requirement jumps to 15 for the remaining portion of range.

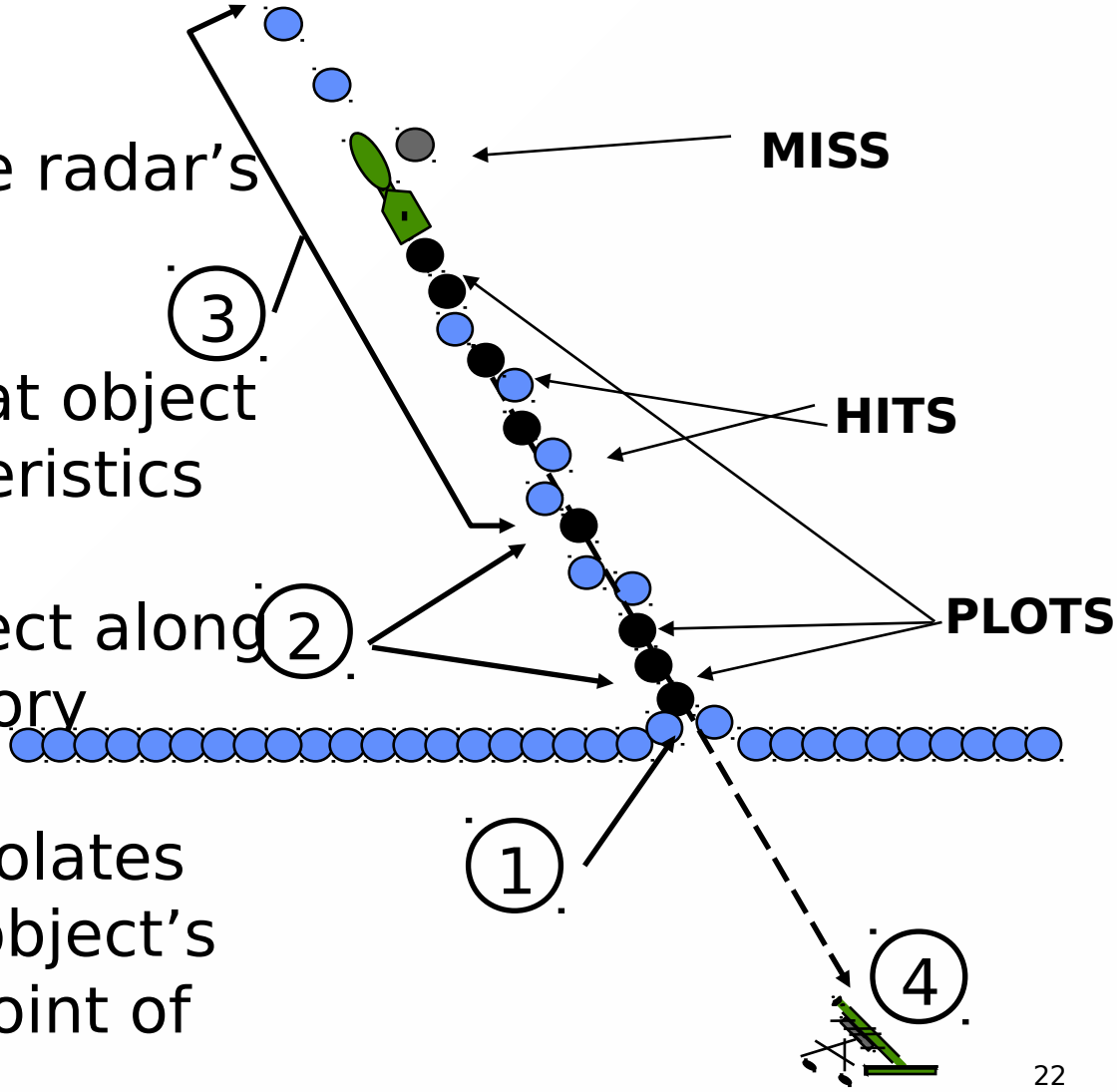
SUMMARY OF THE HOSTILE MODE TRACKING PROCESS

1. Object breaks the radar's search fence.

2. Radar verifies that object has ballistic characteristics

3. Radar tracks object along it's predicted trajectory

4. Computer extrapolates grid location to the object's point of origin and point of impact



TRACK VOLUME

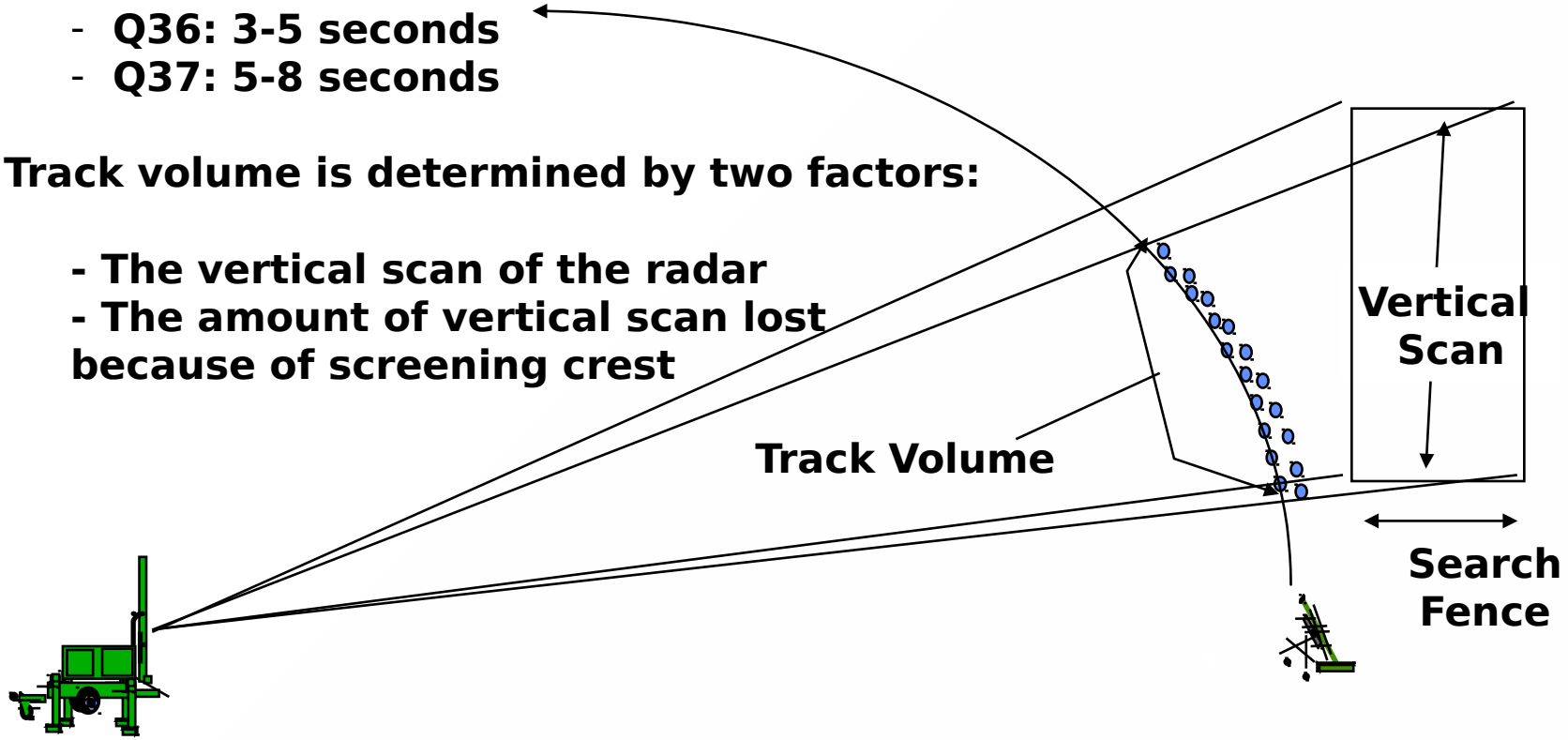
• **The amount of available vertical scan through which an object is tracked.**

• **Each radar typically needs a <u>minimum of 50 mils</u> of track volume in order to track a round for sufficient time to achieve a solution.**

- **Q36: 3-5 seconds**
- **Q37: 5-8 seconds**

•**Track volume is determined by two factors:**

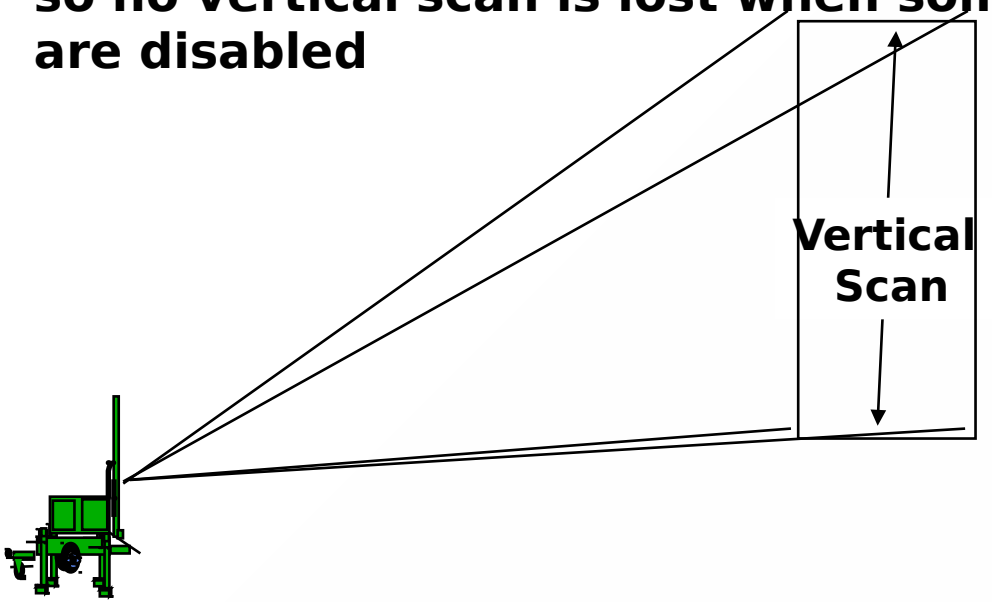
- The vertical scan of the radar
- The amount of vertical scan lost because of screening crest



VERTICAL SCAN

- **Maximum vertical scan for the AN/TPQ-36 radar is approximately 80 mils with all 32 scanning frequencies enabled. (Each frequency that is disabled results in a loss of approximately 2. 5 mils of vertical scan.)**

- **maximum vertical scan for the AN/TPQ-37 radar is approximately 104mils. The AN/TPQ-37 uses phase scanning so no vertical scan is lost when some of the 15 frequencies are disabled**



Q36 = 80 mils
Q37 = 104 mils

SCREENING CREST

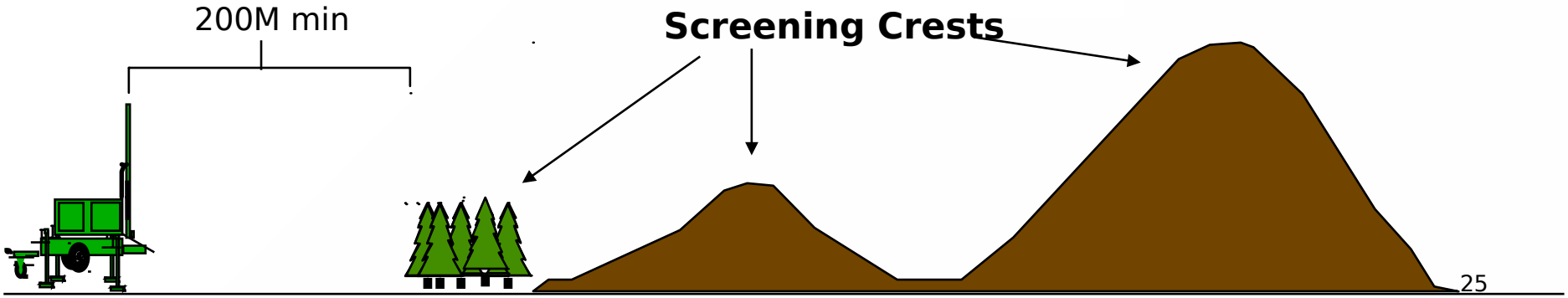
- **Screening crests are any objects in front of the radar (terrain, trees, buildings, etc.).**

- **Reduces available vertical scan of the radar**

- **Reduces the radar's susceptibility to detection and jamming from ground based electronic intelligence (ELINT) systems, if positioned between the radar and the ELINT system.**

- **Double screening crests defeat ground based ELINT systems even better.**

- **Helps reduce the ground clutter effect. (Ground clutter is unwanted returns the radar receives from RF energy bouncing off nearby objects).**



MASK ANGLE

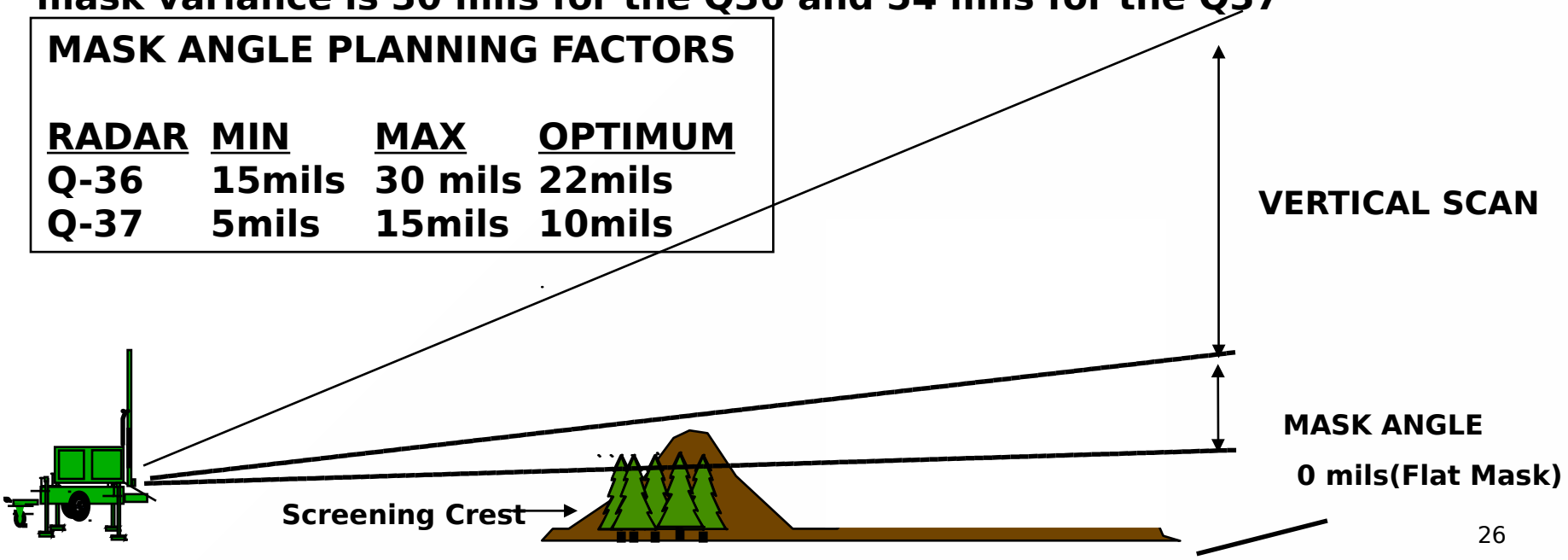
- **MASK ANGLE- Is the vertical angle from the radar (0 mils) to the top of the mask , or screening crest, at a given azimuth.**

•FLAT MASK- Is a single mask angle or a default value in the radar when no mask angle is entered into the radar computer. The flat mask default angle for the AN/TPQ-36 radar is 20 mils. The flat mask default for the AN/TPQ-37 radar is 8 mils.

- **MASK VARIATION - The difference between the highest and lowest mask angles in the radar's search sector. The maximum allowable mask variance is 30 mils for the Q36 and 54 mils for the Q37**

MASK ANGLE PLANNING FACTORS

RADAR	MIN	MAX	OPTIMUM
Q-36	15mils	30 mils	22mils
Q-37	5mils	15mils	10mils



WHY DO THE FIELD GRADES CARE ABOUT THIS STUFF?

Must position the radar on the battlefield to maximize the radar's probability of detecting enemy indirect fire systems while at the same time minimizing the radar's vulnerability to the enemy.

CALCULATING TRACK VOLUME

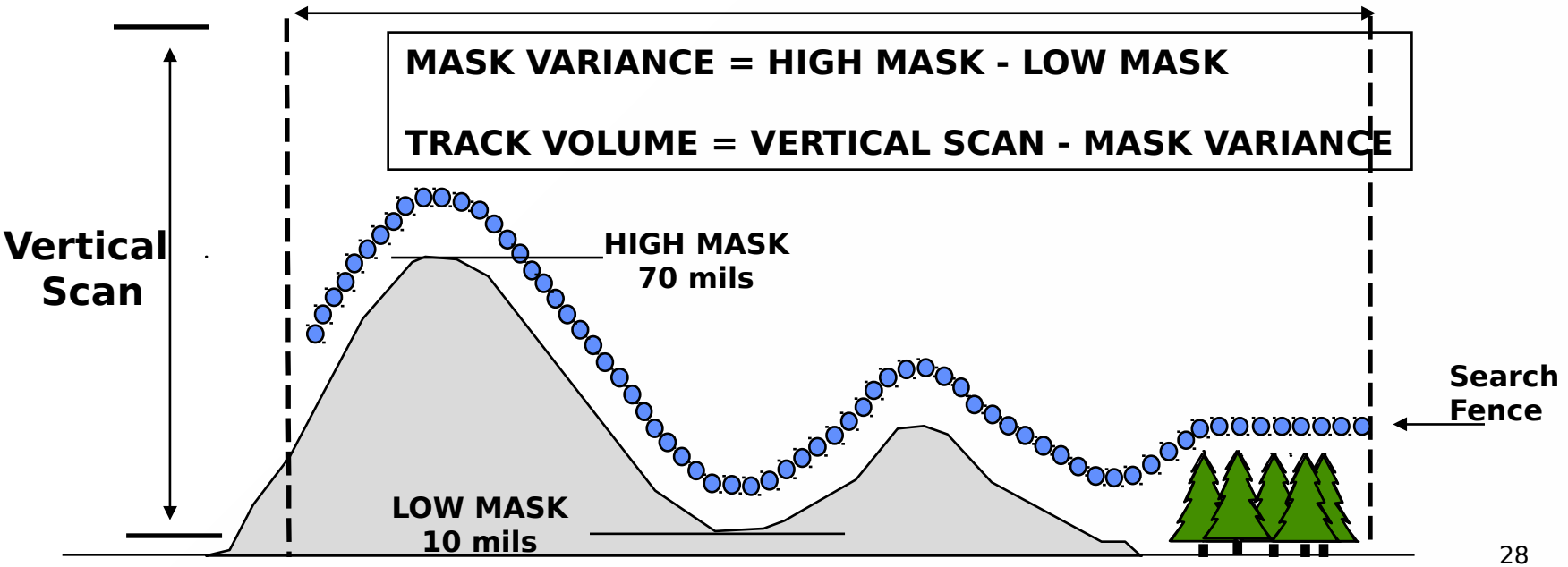
STEP 1: Determine lowest mask angle in the search sector

STEP 2: Determine highest mask angle in the search sector

STEP 3: Determine mask variance by subtracting the low mask angle from the high mask angle

STEP 4: Determine available track volume by subtracting the mask variance from the vertical scan for the type radar

- **If the track volume is greater than 50 mils, then the position is adequate.**
- **If the track volume is less than 50 mils then find new position or adjust low or high mask angle to obtain at least 50 mils.**


SEARCH SECTOR
MASK VARIANCE = HIGH MASK - LOW MASK
TRACK VOLUME = VERTICAL SCAN - MASK VARIANCE
Vertical Scan
HIGH MASK 70 mils
LOW MASK 10 mils
Search Fence

CALCULATING TRACK VOLUME
Q36 Example

STEP 1: Lowest mask angle = 10 mils

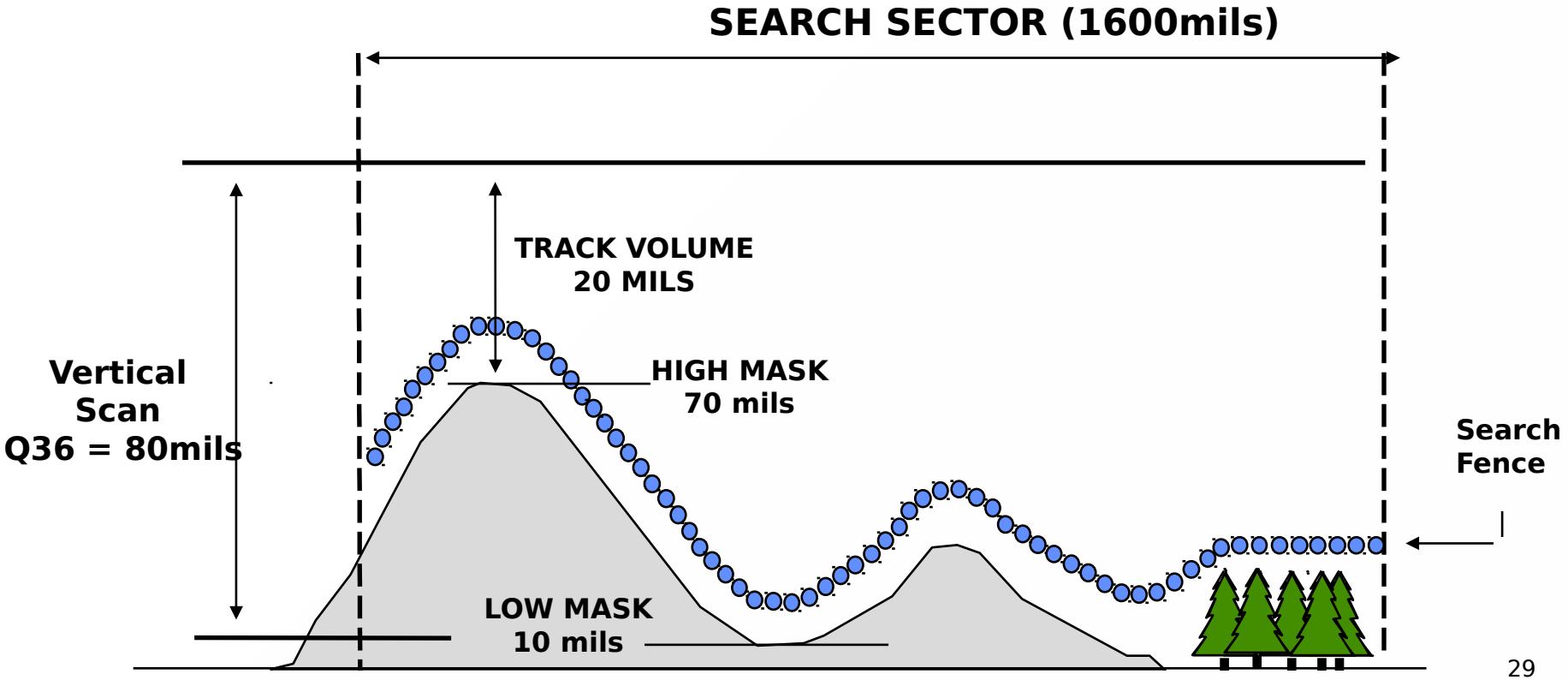
STEP 2: Highest mask angle = 70 mils

STEP 3: Mask variance: 70 mils - 10 mils = 60 mils

STEP 4: Track volume: 80mils - 60 mils = 20 mils

MASK VARIANCE = HIGH MASK - LOW MASK

TRACK VOLUME = VERTICAL SCAN - MASK VARIANCE



SOLVE THE PROBLEM

Option 1: Raise the low mask

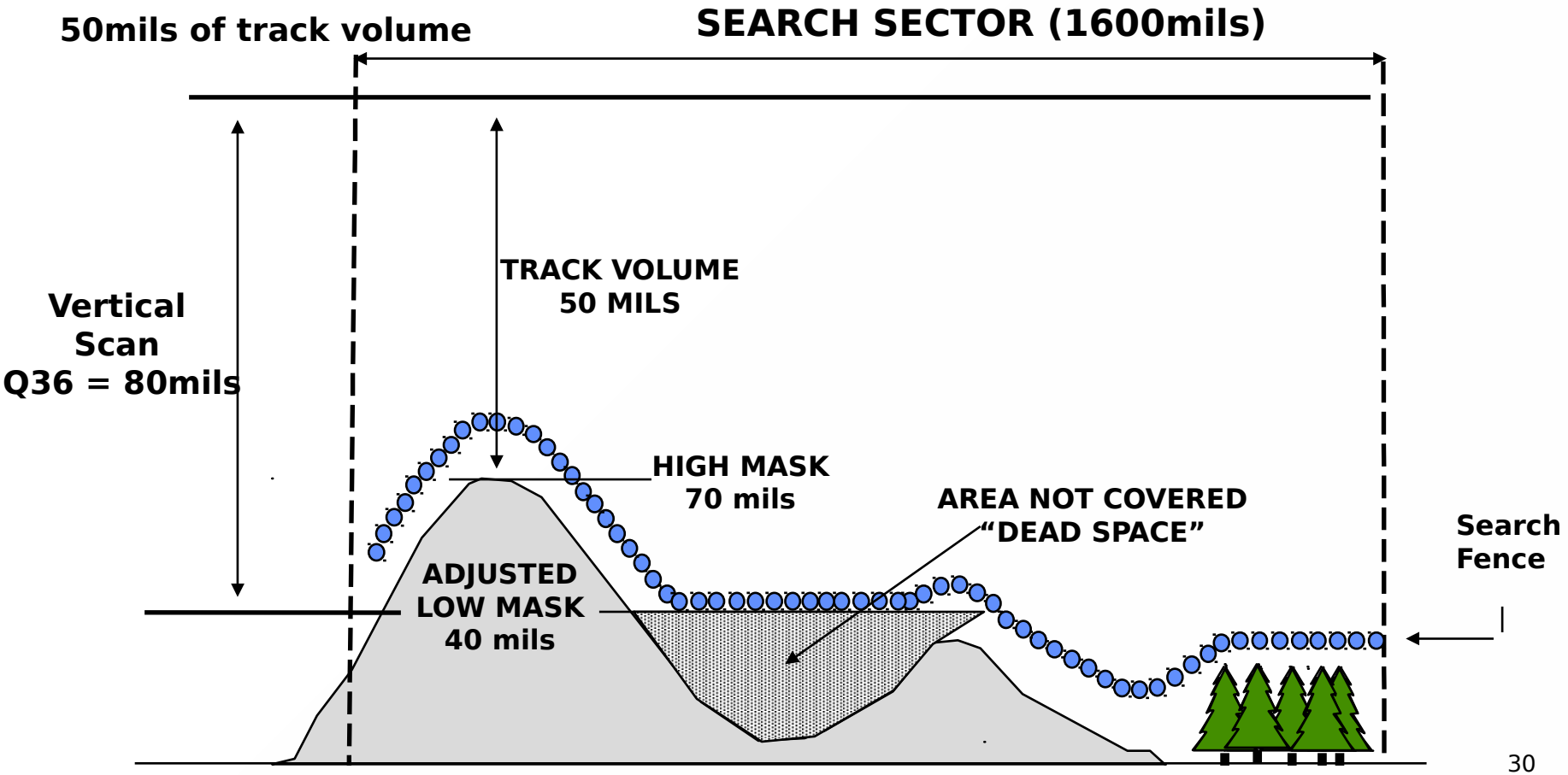
- **If radar must occupy this position, you must**

adjust the mask variance in order to obtain

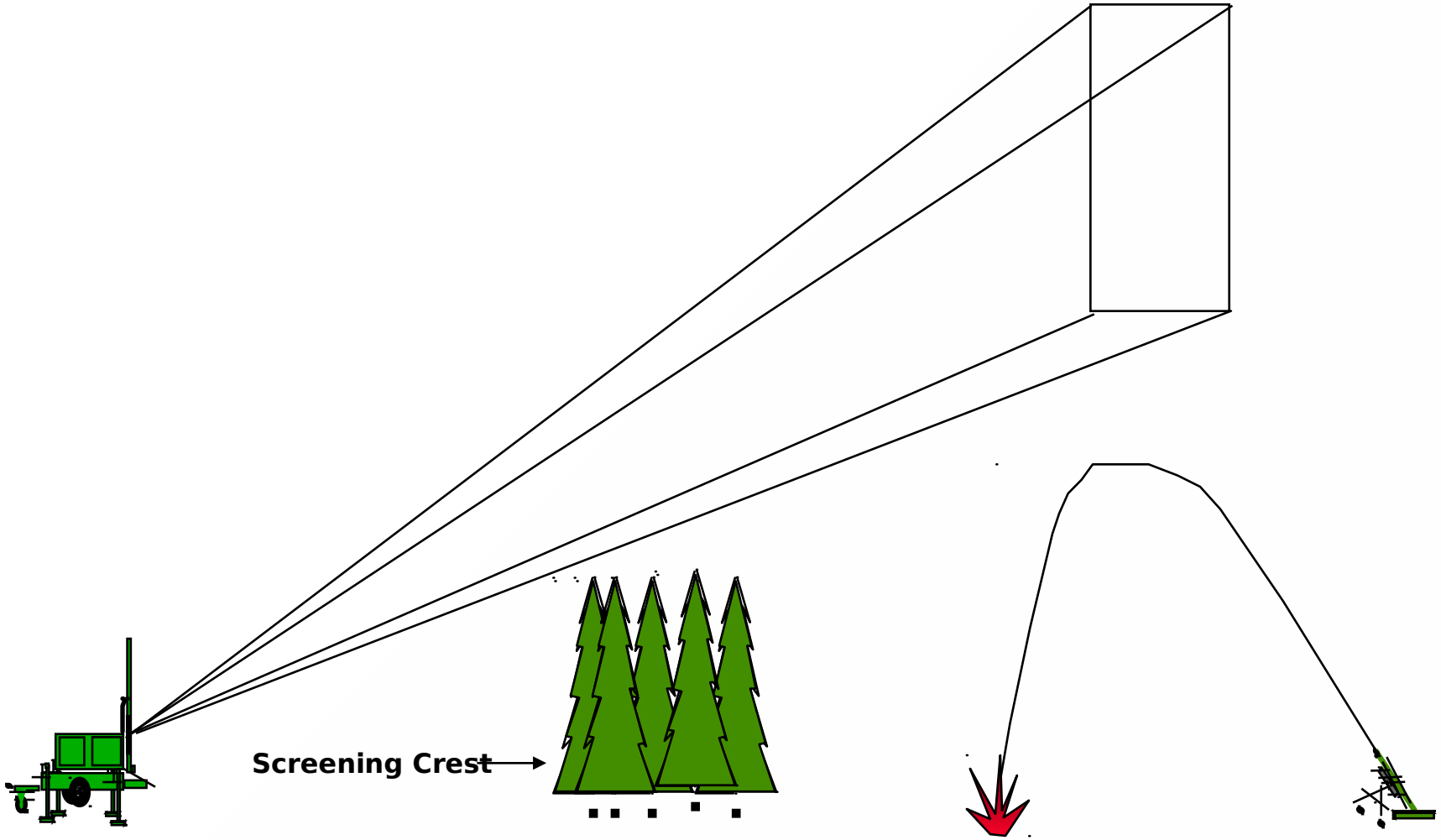
50mils of track volume

MASK VARIANCE = HIGH MASK - LOW MASK

TRACK VOLUME = VERTICAL SCAN - MASK VARIANCE


SEARCH SECTOR (1600mils)
Vertical Scan Q36 = 80mils
TRACK VOLUME 50 MILS
HIGH MASK 70 mils
AREA NOT COVERED "DEAD SPACE"
Search Fence
ADJUSTED LOW MASK 40 mils

POSSIBLE ADVERSE EFFECT OF RAISING LOW MASK



CALCULATING SEARCH FENCE HEIGHT

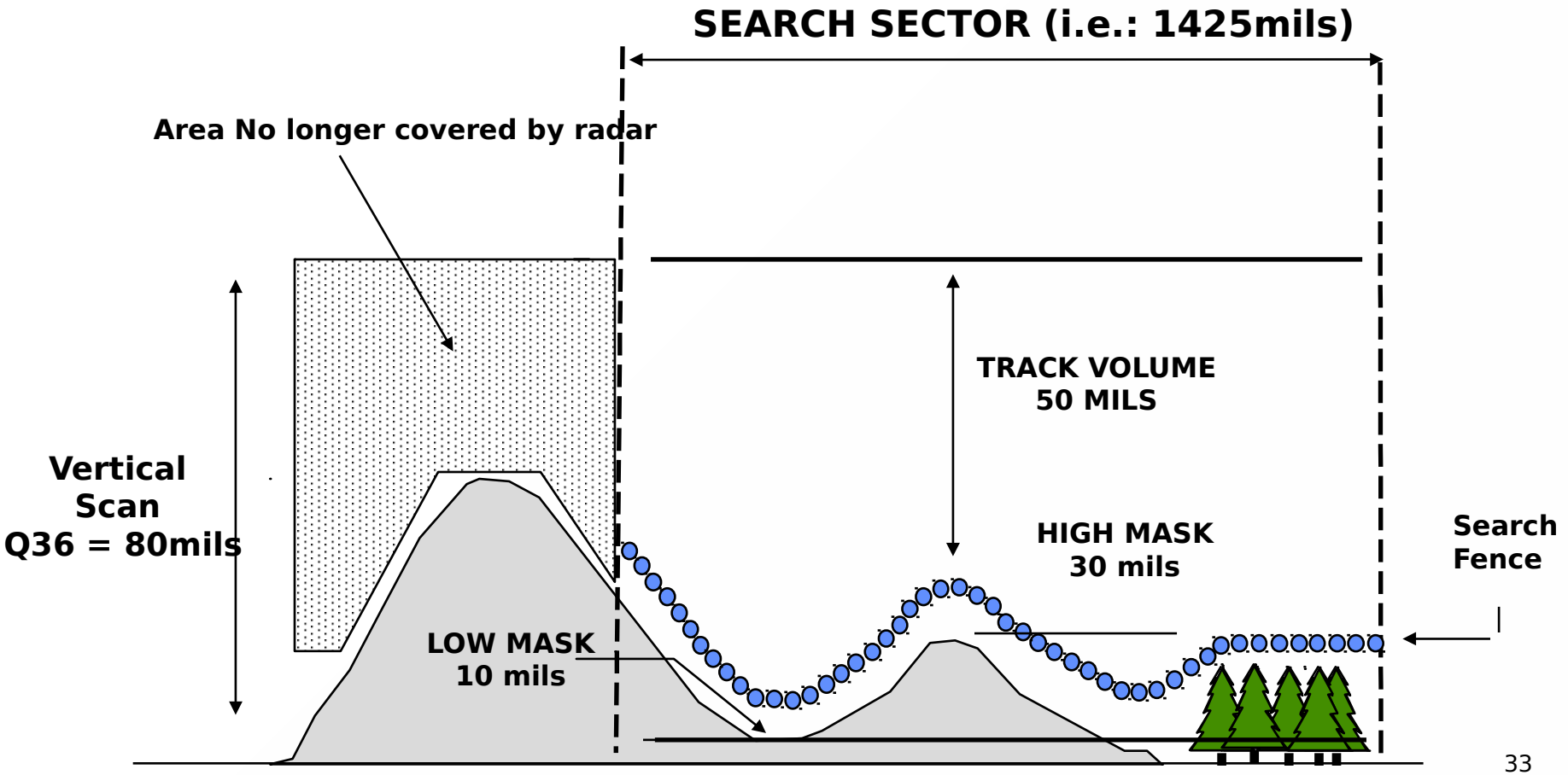
- **Low mask = 70 mils (above recommended maximum low mask)**
- **Actual low mask = 85 mils (radar automatically adds 15 mils to the low mask)**
- **Distance of suspected enemy 81mm mortar position from radar is 10kms.**
- **Average ordinance of 81mm from TFT is 1000 ft.**
- **How high above the suspected mortar is the search fence?**

- **W (distance) = R (range in meters/1000) x m (mils)**
- **W = 10 x 85 = 850meters**

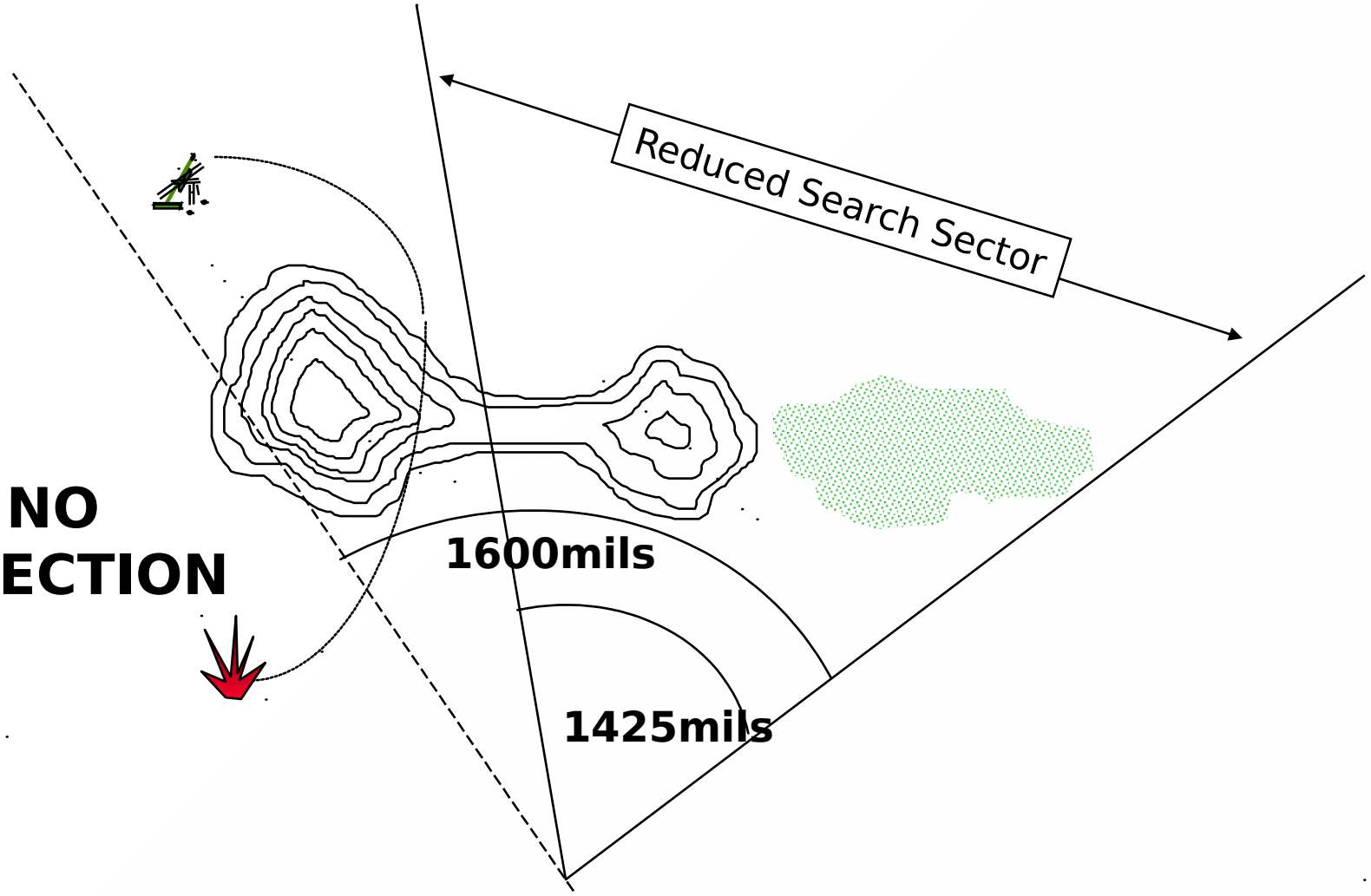
- **850 meters X 3 = about 2550 feet (Probably will NOT detect the 81 mm**

SOLVE THE PROBLEM

Option 2: Modify the search sector

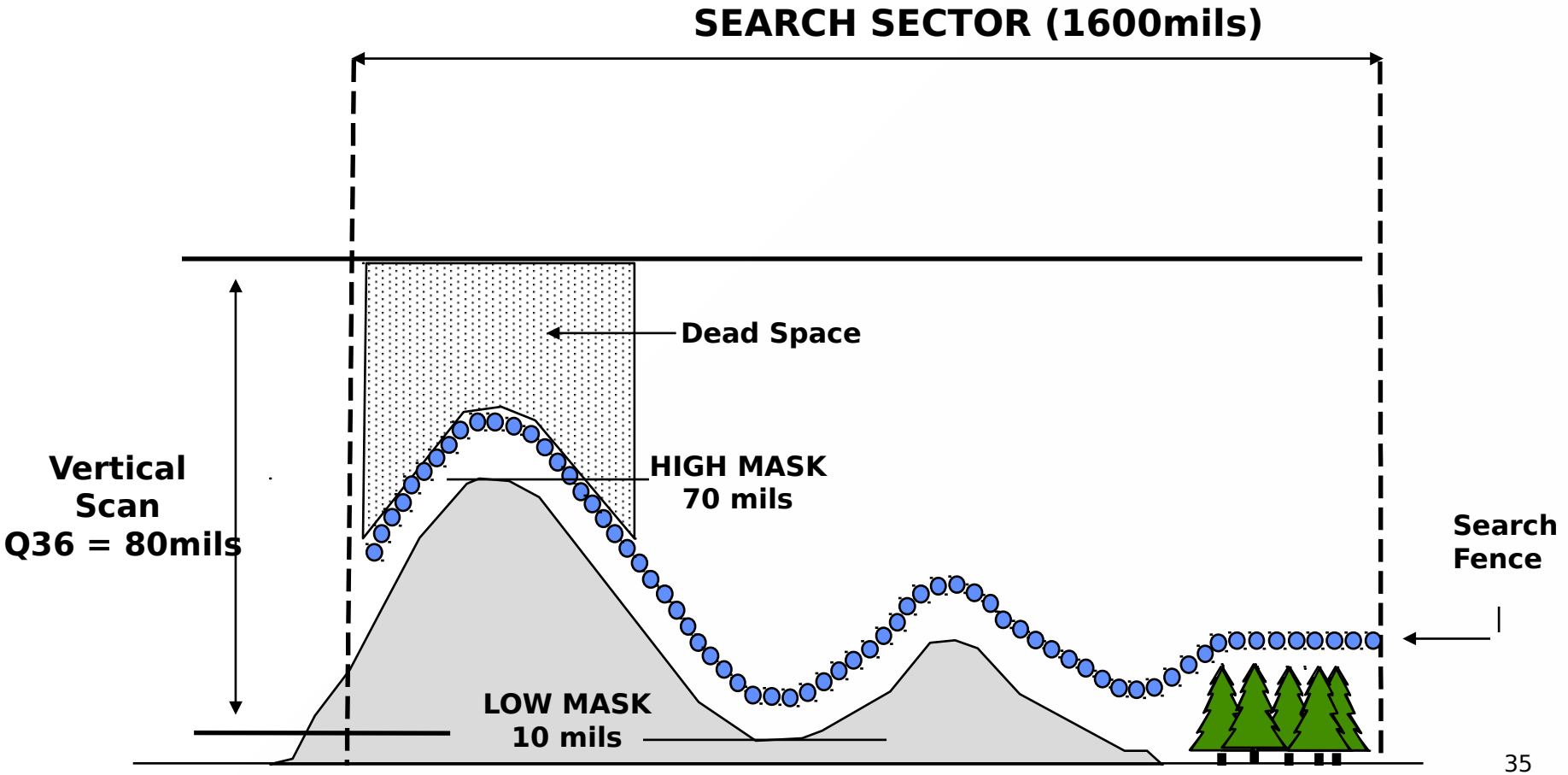


POSSIBLE ADVERSE EFFECT OF MODIFYING THE SEARCH SECTOR

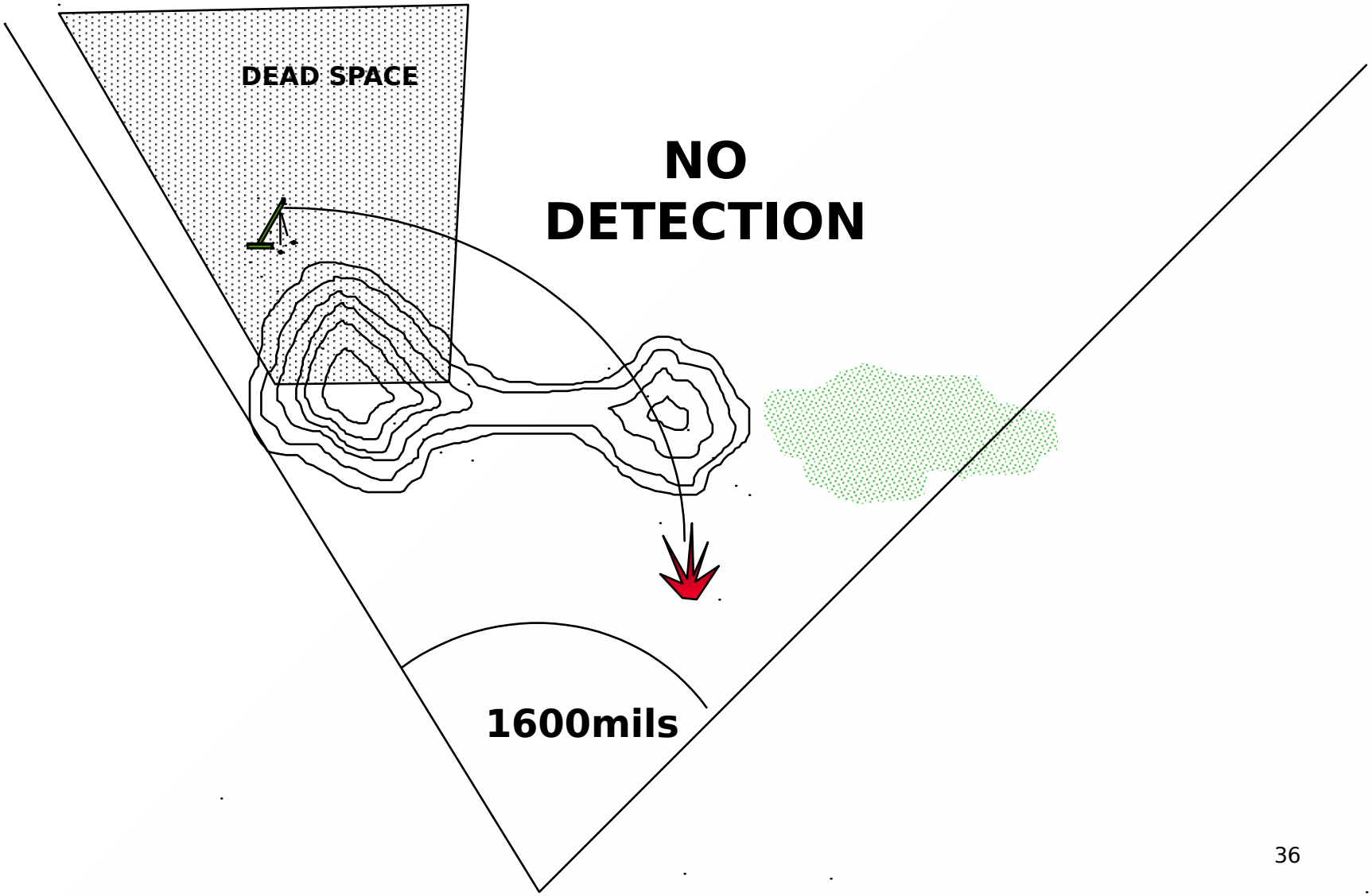


SOLVE THE PROBLEM

Option 3: Do nothing



POSSIBLE ADVERSE EFFECT OF DOING NOTHING



CALCULATING TRACK VOLUME PE

Q37 Example - What's your solution?

STEP 1: Lowest mask angle

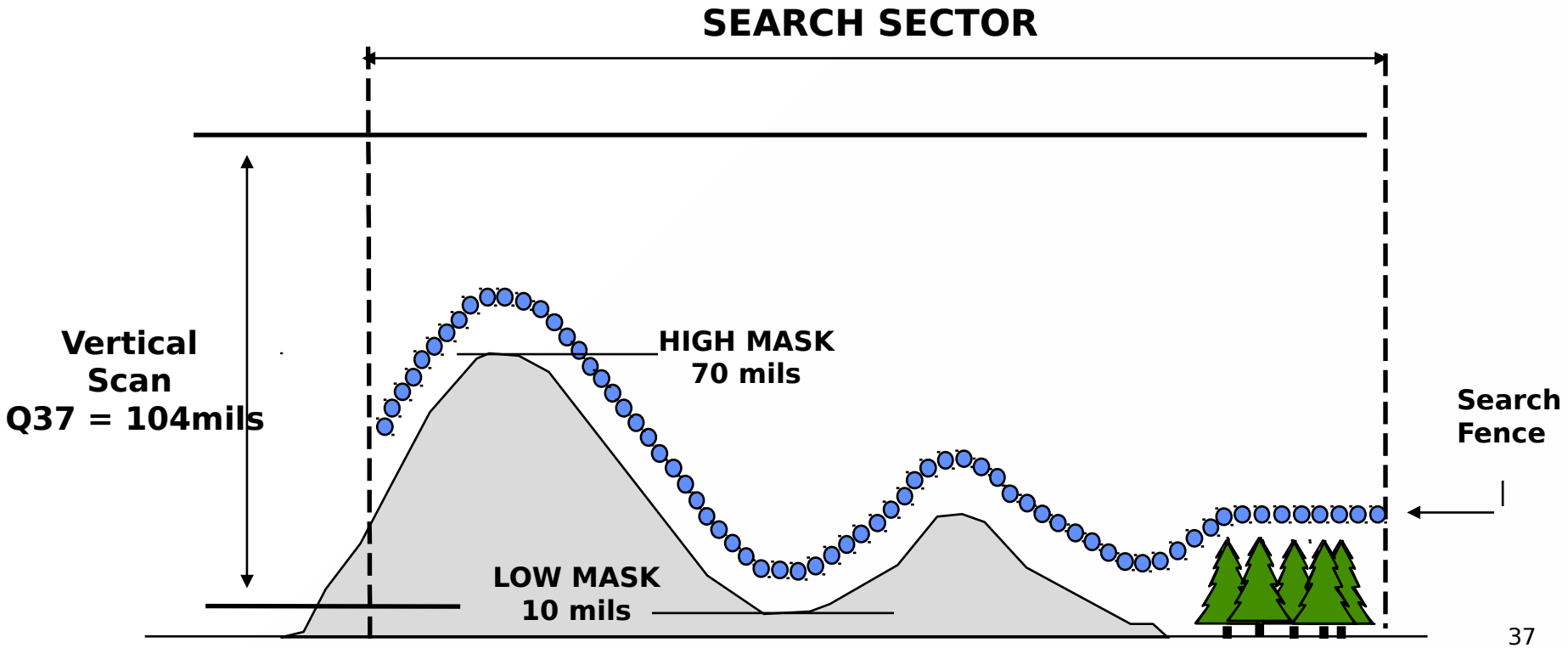
STEP 2: Highest mask angle

STEP 3: Mask variance

STEP 4: Track volume

MASK VARIANCE = HIGH MASK - LOW MASK

TRACK VOLUME = VERTICAL SCAN - MASK VARIANCE



ONE POSSIBLE SOLUTION

Raise the Low Mask

STEP 1: Lowest mask angle: 10 mils

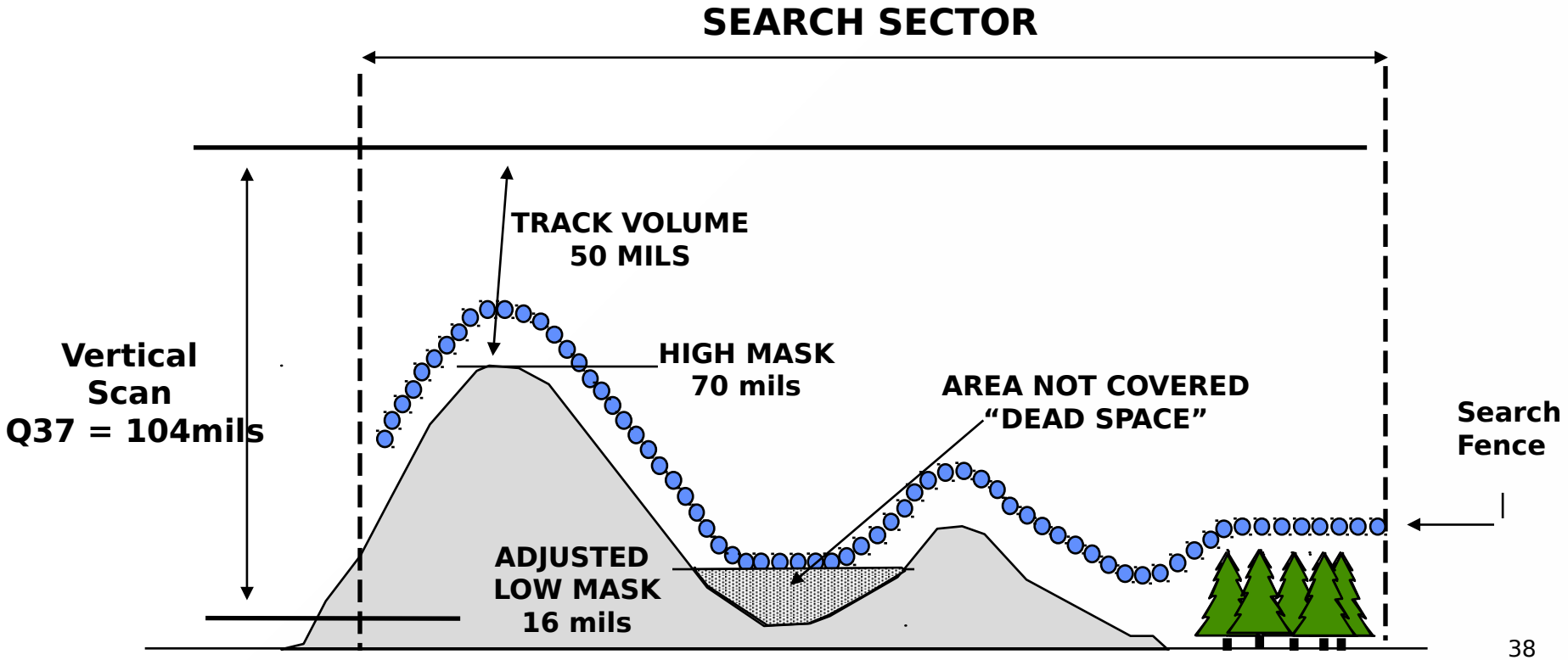
STEP 2: Highest mask angle: 70 mils

STEP 3: Mask variance: 70 - 10 = 60 mils

STEP 4: Track volume: 104 - 60 = 44mils

MASK VARIANCE = HIGH MASK - LOW MASK

TRACK VOLUME = VERTICAL SCAN - MASK VARIANCE



WHAT'S REALLY IMPORTANT FOR FIELD GRADES TO KNOW?

- **The lower the mask the greater the probability of detection.**
- **Distance to screening crest, min, max, and optimum low mask mils are just planning guidelines. The actual elevation of search fence above ground over the suspected hostile weapon area is what is really important. Is the search fence low enough the "see a round?"**
- **Must have a minimum of 50 mils of track volume in order to reasonably be assured of tracking a projectile long enough to determine a solution.**

DETECTION PROBABILITIES

Many factors determine whether or not the radar will detect an object that “fly's” through its’ beam. As a general rule of thumb the probability of detection is primarily affected by:

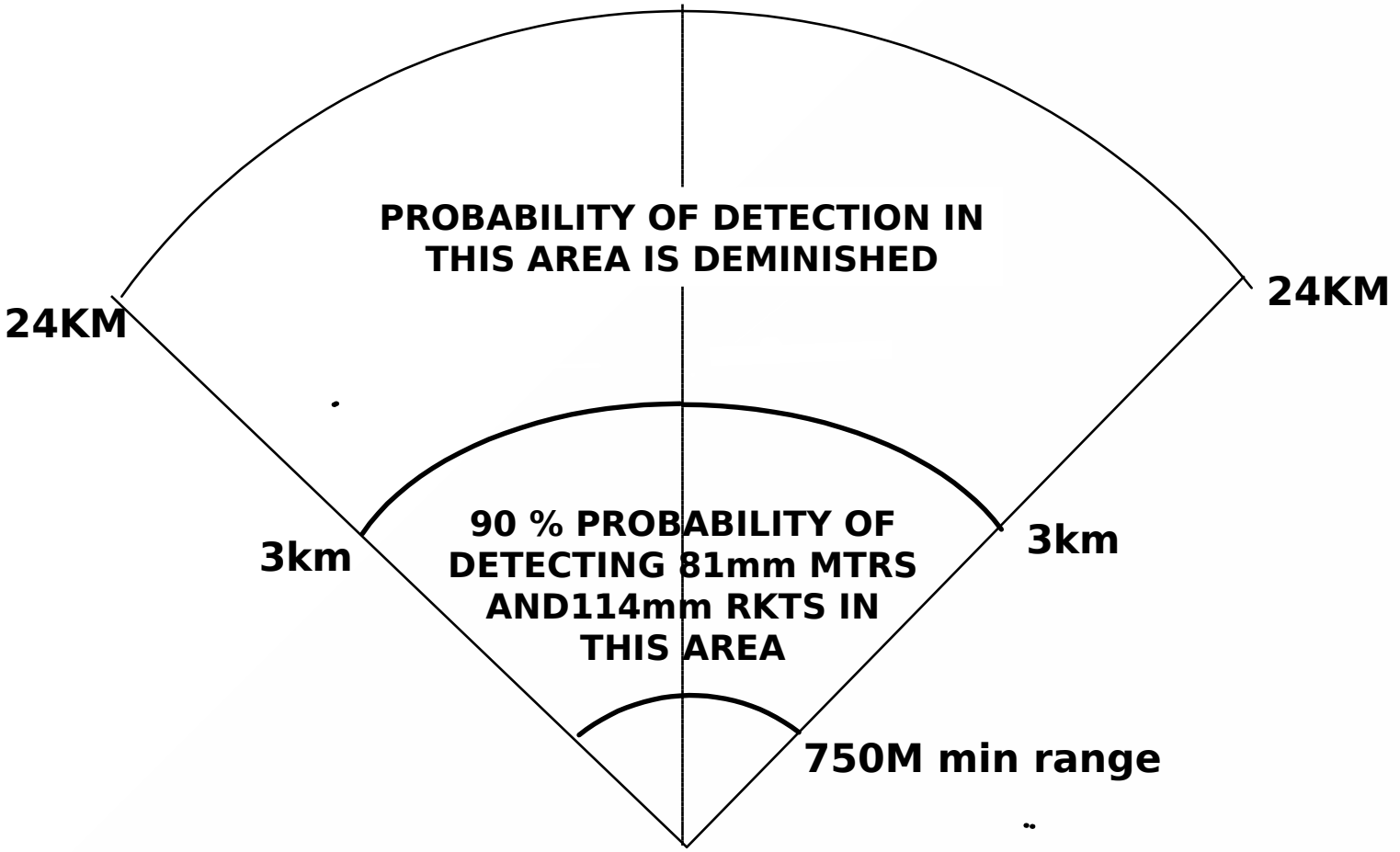
- **Distance Away from the Radar**. The farther away the object is from the radar the less likely the radar is to detect it.

- **Distance Left or Right of the Center of the Search Sector**. The farther away the object is from the center of the search sector the less likely radar is to detect it.

- **Size of Object**. The smaller the object is the less likely the radar is to detect it.

Q36 PROBABILITY OF DETECTION

VIDEO INTEGRATION “OFF”

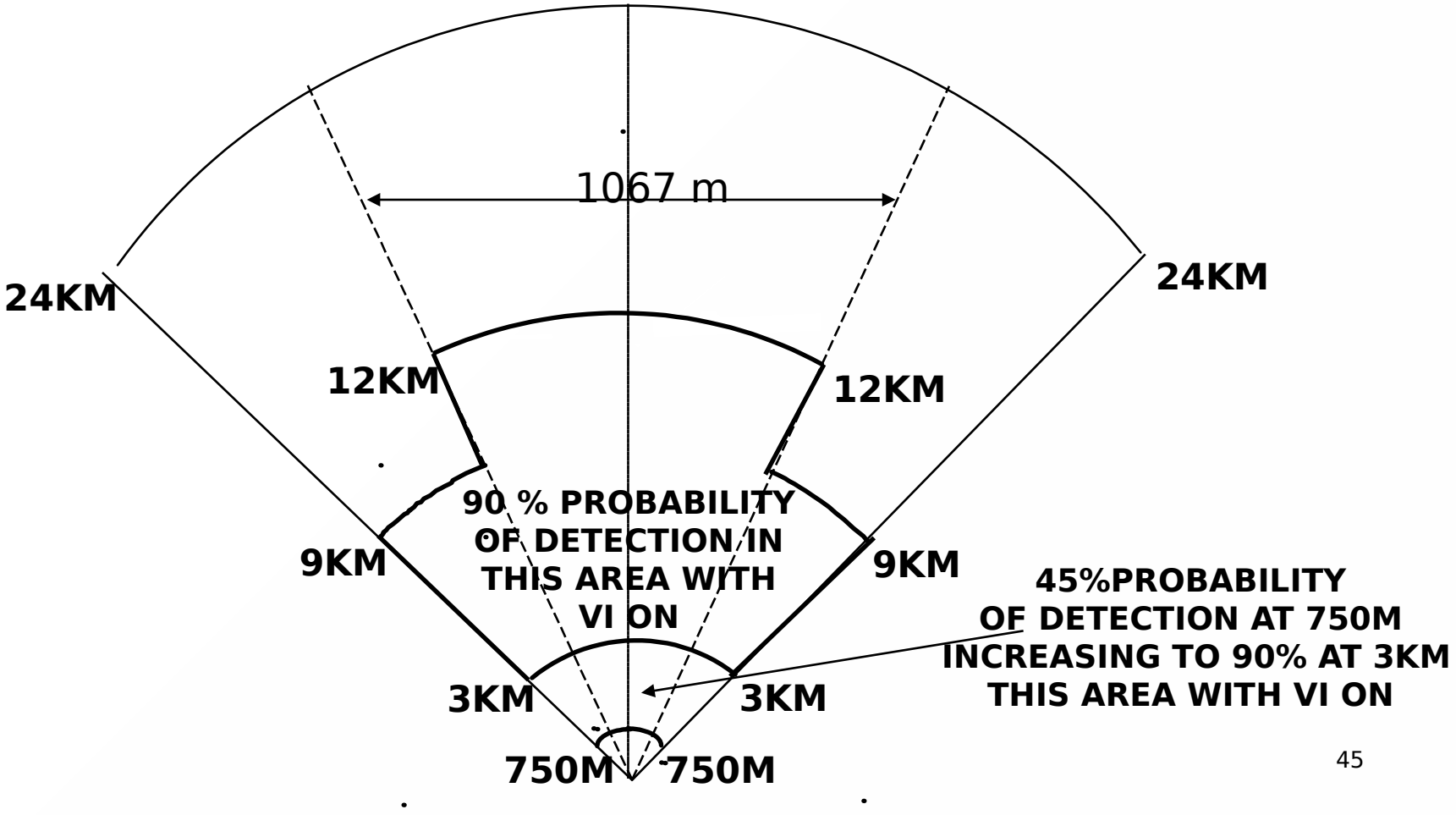


WHAT IS VIDEO INTEGRATION

- **A radar “beam” looks at a spot for a given amount of time.**
- **The beam can consist of 1, 2 or 4 dwells.**
- **A dwell consist of 16 radar pulses, thus a target could be illuminated 16 times in a single dwell.**
- **With VI on the Q36 uses the 2 or 4 dwell mode, thus increasing the number of times a target could be illuminated to 32 or 64. (Only the Q36 has VI capability)**
- **<u>VI improves the radar’s probability of detecting objects beyond 3km, but reduces the probability of detection short of 3km.</u>**

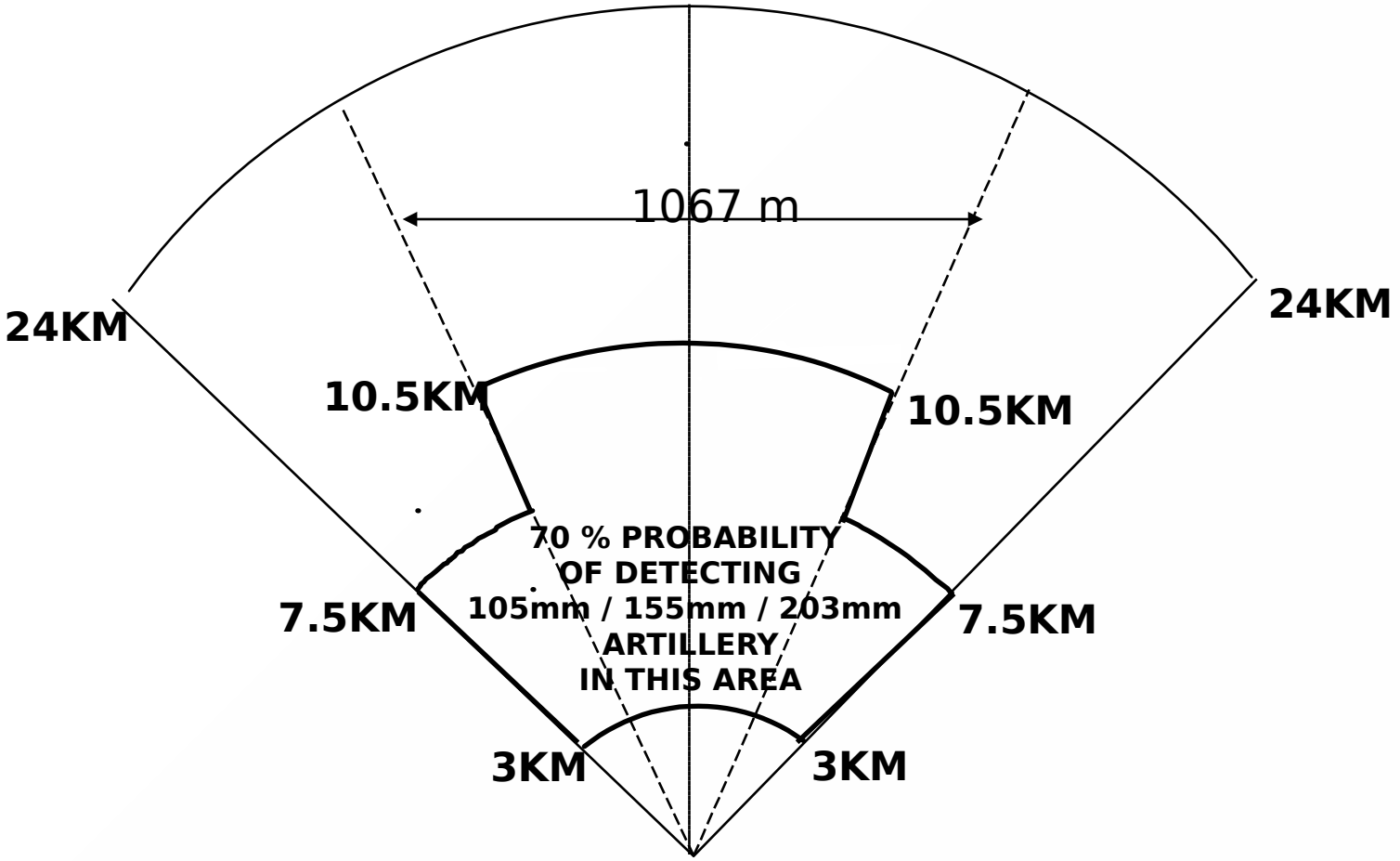
Q36 MORTAR PROBABILITY OF DETECTION

VIDEO INTEGRATION "ON"



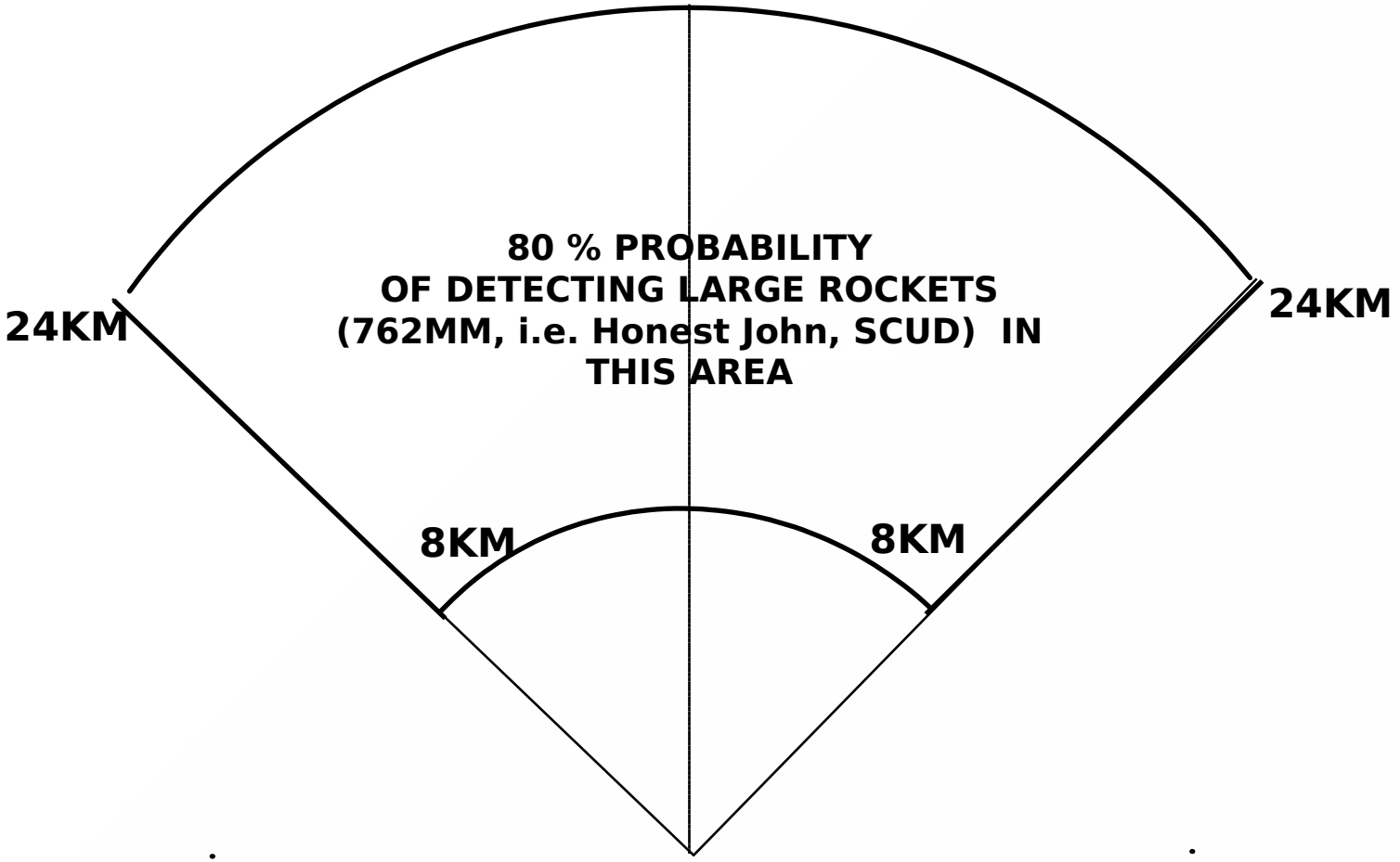
Q36 ARTILLERY PROBABILITY OF DETECTION

VIDEO INTEGRATION "ON"



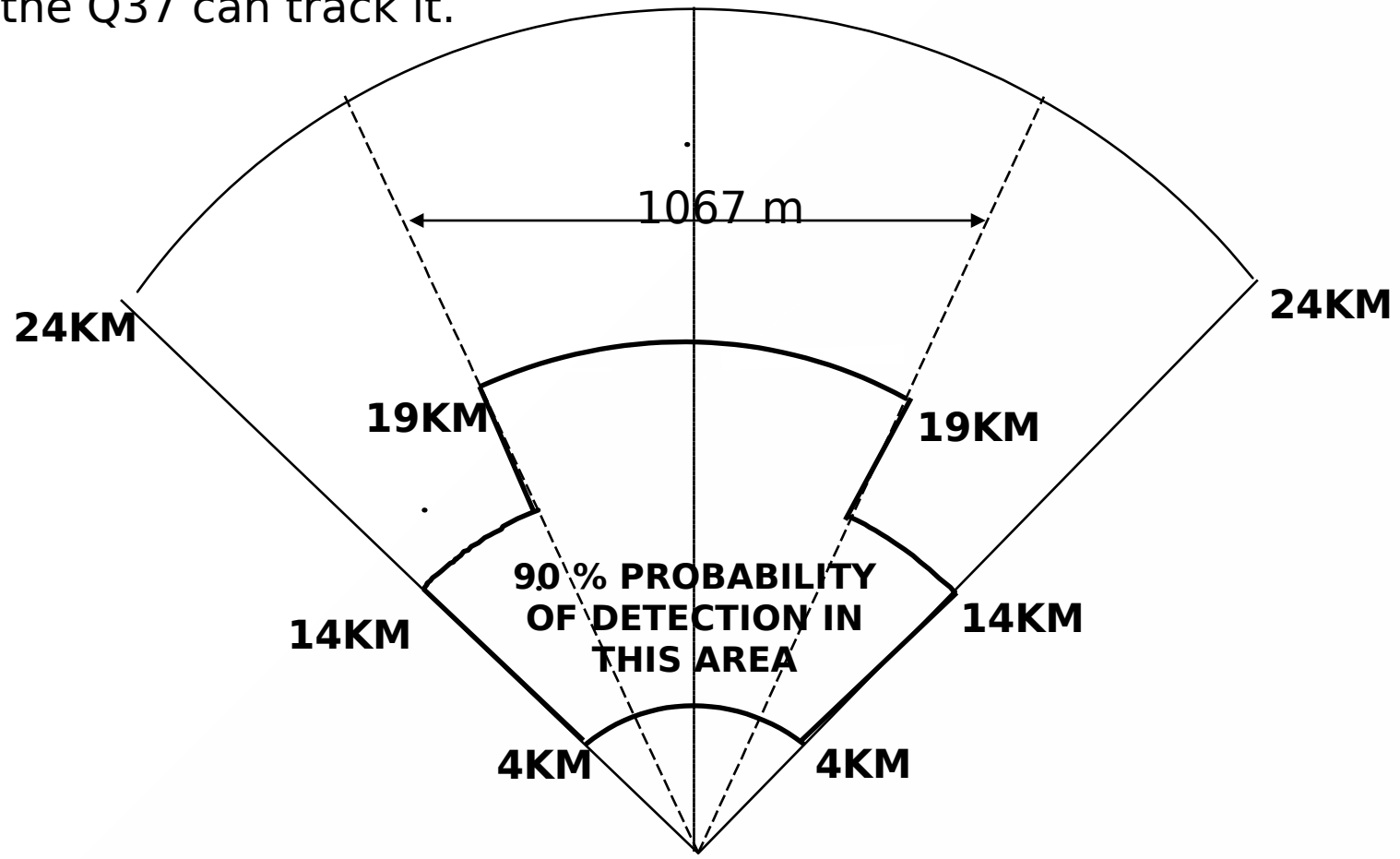
Q36 ROCKET PROBABILITY OF DETECTION

VIDEO INTEGRATION "ON"

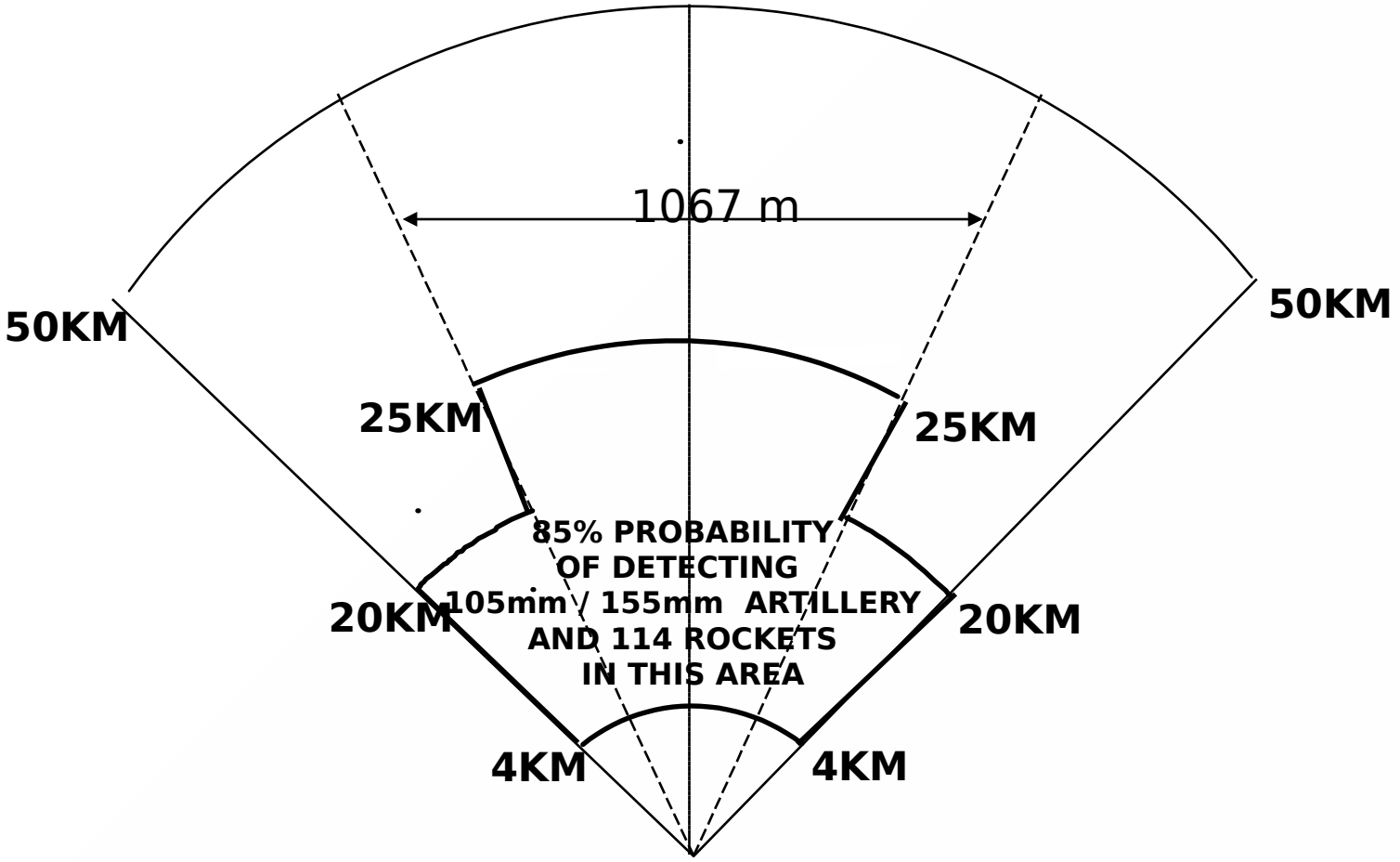


Q37 MORTAR PROBABILITY OF DETECTION

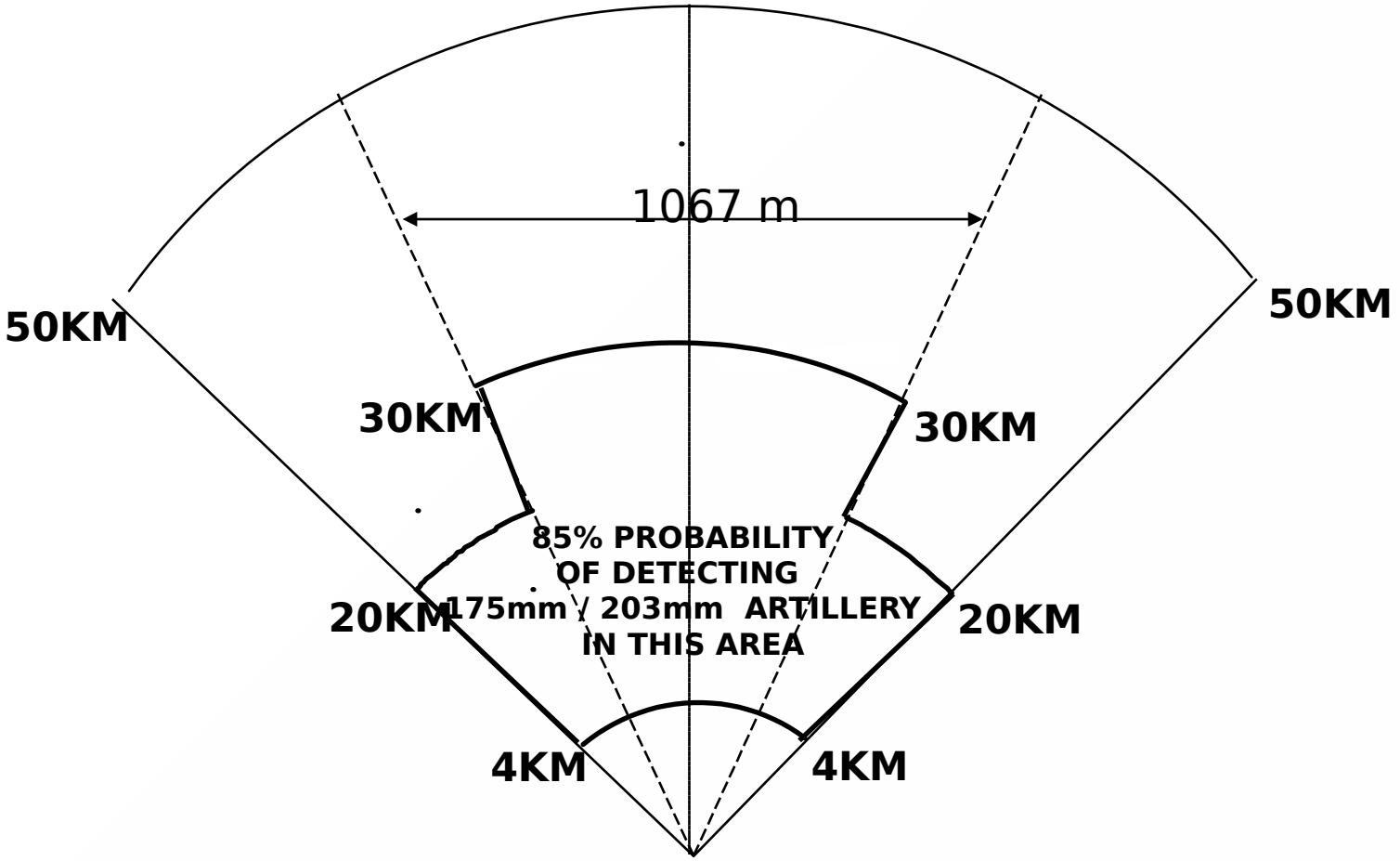
Q37 is not designed to detect mortars, however if the velocity of the object is greater than 130m/s (higher charge mortars) then the Q37 can track it.



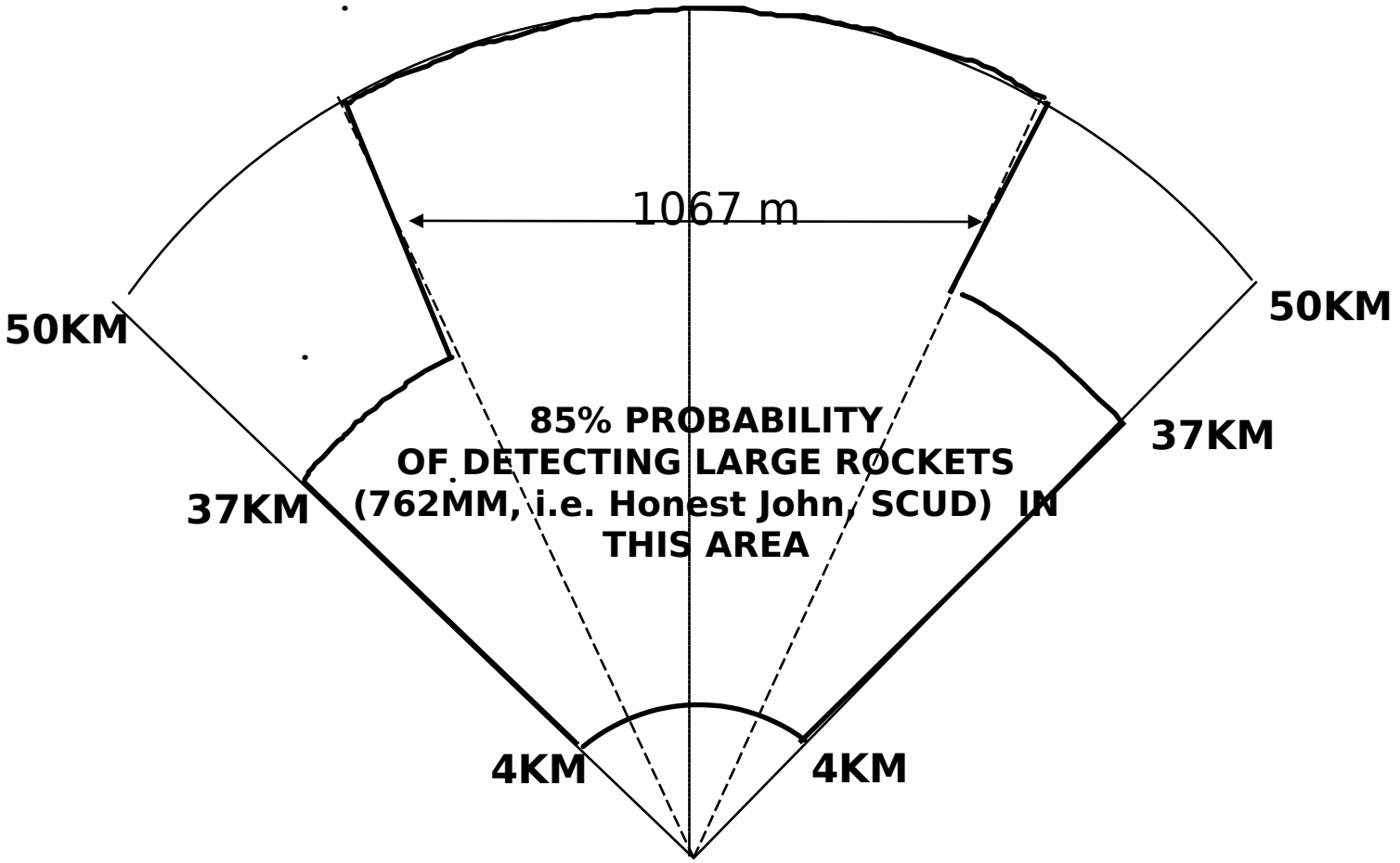
Q37 LIGHT AND MEDIUM ARTILLERY PROBABILITY OF DETECTION



Q37 HEAVY ARTILLERY PROBABILITY OF DETECTION



Q37 LARGE ROCKET PROBABILITY OF DETECTION



THREE CATEGORIES OF TARGETS

- **Normal Targets:** Mortars, artillery, and rockets detected, verified, and tracked by the main beam of the radar.

- **False Targets:** Information that causes the radar to report a target to the operator when there is no actual targets.
  - Electronically induces signals
  - Side lobe tracks (helicopters, aircraft, vehicles, other ground clutter)

- **Unwanted Targets:** Targets other than mortar, artillery, or rocket which the radar reports to the operator. These are objects which pass through the beam and behave in a ballistic manner.
  - Tank rounds, especially skips / ricochets
  - Individual rounds as small as 50 caliber
  - Bursts of small arms
  - Shrapnel or other material from explosions (spall)

RADAR POSITIONING

RADAR POSITIONING CONSIDERATIONS

- Accessibility
- Communications
- Cover & Concealment
- Routes of Approach
- Security
- Survey
- Slope (Cant)
- Area in front of the Antenna
- Screening Crest
- Aspect Angle
- Track Volume
- Cable lengths
- RF Hazard

RADAR POSITIONING CONSIDERATIONS SURVEY REQUIREMENTS

- Q36 & Q37 require positional and directional control.

- Survey Control Methods
  - PADS. Primary means of providing survey control.
  - Modular Azimuth Positioning System (MAPS). Secondary means of establishing survey control.
  - Hasty Survey. Last means of establishing control (PLGR/Map spot & AC).

- Desired Positional Control:
  - Horizontal Control: 10 meter CEP
  - Vertical Control: Q36 = 10 meter CEP, Q37 = 3 meter CEP

- Desired Directional control: +/- 0.4 mil (PE)

- Q36, ver VII & VIII and Q37 Block upgrades are equipped with the onboard modular azimuth positioning system (MAPS)

RADAR POSITIONING CONSIDERATIONS SURVEY REQUIREMENTS

- **Radar must position itself directly over the OS.**
- **Antenna is sighted onto the EOL.**
- **Radar is NOT “laid” like a howitzer.**

RADAR POSITIONING CONSIDERATIONS MODULAR AZMUTH POSITIONING SYSTEM (MAPS)

- MAPS provides onboard survey capability to the radar.

- MAPS Initialization. Each time MAPS is turned on it must initialize.
  - Initialize over the most accurate survey available (SCP, PADS, PLGR, map spot, in order).
  - Initialization requires 10-15 minutes to complete.

- Zero-Velocity (Z-VEL) Corrections - “Updates”
  - Z-VEL updates are periodically performed when the MAPS is moving.
  - Computer data unit (CDU) prompts operator to stop approximately every 10 minutes.
  - Updates take approximately 30 seconds to complete.

RADAR POSITIONING CONSIDERATIONS

- **Area in Front of the Radar**
  - **Obstructions.** No obstructions (i.e.: camouflage nets, equipment, vegetation) higher than the bottom of the radar antenna (@ 3 feet)
  - **Clear Area in Front of Radar.** 200 meters(Q36), 300 meters(Q37)
  - **Slope.** Ideally, ground should gently slope downward away from the radar for 200/300 meters then gradually rise up to the screening crest. This reduces multipath errors (target location error caused when transmit or return signals travel by more than one path)

RADAR POSITIONING CONSIDERATIONS

- **Mounds**. If a mound is required to raise antenna above any obstructions, ensure it is high enough to safely radiate above equipment and soldiers (average height of mound required is 5-6 feet)

- **Guns**. Maximize the distance between the radar and nearby howitzers. Percussion from the guns will cause faults and can damage radar.

- **Slope ("Cant").** No more than 120 mils (7 degrees).

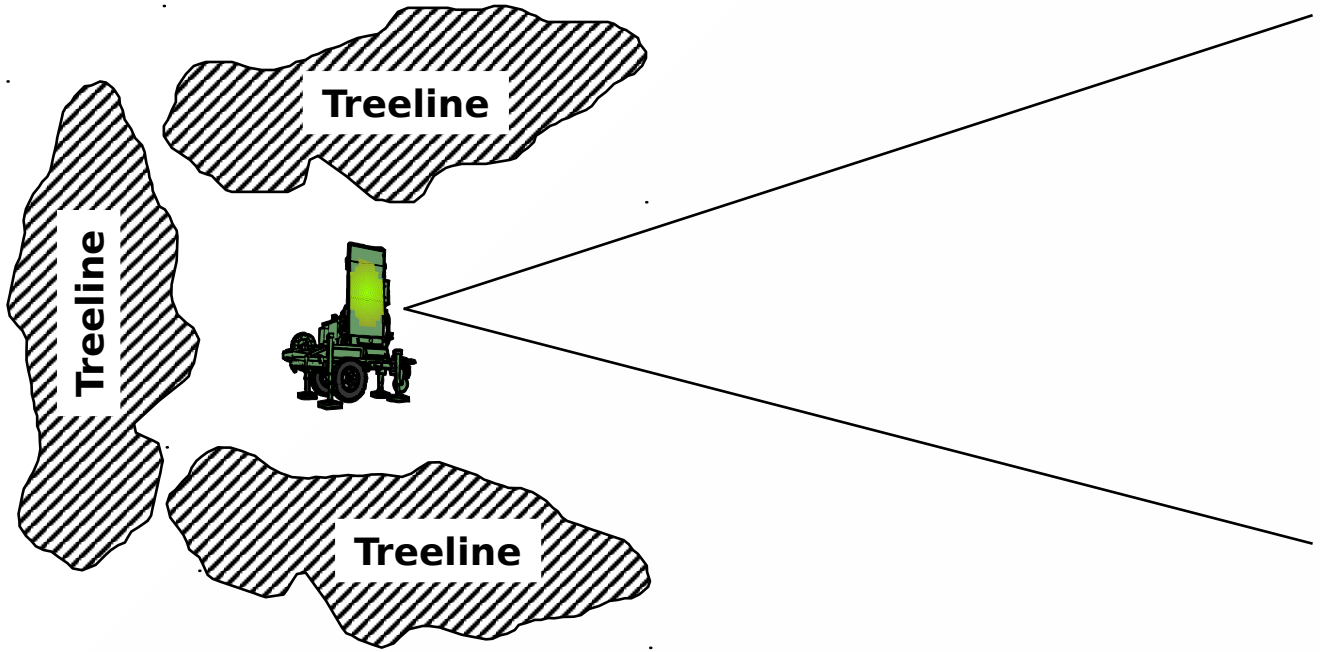
- **Tunneling.** Reduce electronic signature by creating a tunneling effect.

RADAR POSITIONING CONSIDERATIONS

TUNNELING

- Tunneling reduces the side, top, or back lobes or radiation reducing the likelihood of electronic detection of the radar.

- Tunneling is accomplished by positioning the radar so that vegetation is to the sides and rear of the radar. Tunneling can also be accomplished by digging in or sandbagging around the radar.



RADAR POSITIONING CONSIDERATIONS

- **Screening Crest**. Ideally, double screening crests, 1000 meters in front of radar, 15-30 mils for Q36, 5-15 mils for Q37.

- **Track Volume.** Maximize track volume (minimize mask angle) and search sector width.

- **Aspect Angle**. Must be less than 1600 mils (Hostile mode) to the target path in order to detect.

- **Communications**. Must talk (voice & digital) to associated FDC/TOC

- **Ammunition Safety**. Radar should be a minimum of 268M from any electronically armed / detonated ammunition (Claymore, det caps, VT)

RADAR POSITIONING CONSIDERATIONS

- **Dispersion.** Length of the cables which attach the shelter and generator to the antenna limit the amount of dispersion.
  - Q36. Shelter - 40 M, generator - 40 M
  - Q37: Shelter - 40 M, generator - 32 M

- **Jamming.** Position radar away from other radars. Radars in close proximity to each other or “looking” at each other may cause jamming.

- **Security.** Radar section cannot operate radar and provide its own security. Five man section.

- **HARM Missiles**. The radar will attract HARM missiles!

RADAR POSITIONING CONSIDERATIONS

RF HAZARD

- **Reference: CECOM msg, released Feb 99**

- **Q36**
  - Normal Operation Scan (scanning 0400m-1600m, i.e. hostile fire mode): 5 meters
  - Narrowed Sector Scan (less than 0400m ie. friendly fire mode)): 30 meters
  - Fixed Scan (specialized maintenance): 75 meters

- **Q37**
  - Normal Operation Scan (scanning 0400m-1600m): 7 meters
  - Narrowed Sector SCan (less than 0400m): 40 meters
  - Fixed Scan (specialized maintenance): 100 meters

MAXIMIZE THE LIKELYHOOD OF DETECTION THE ENEMY BY:

- **Maximizing the track volume (must have a min of 50 mils).**
- **Minimizing the screening crest/mask angle**
- **Orienting the center search sector on likely enemy indirect fire position areas.**
- **Minimizing the distance between the enemy firing position and the radar.**
- **Ensure aspect angle to target is within 0 to 1600 mils**

MINIMIZE THE VULNERABILITY OF THE RADAR BY:

- **Having a screening crest; double is best.**
- **Position radar on ground which slopes away from antenna for at least 200 meters then rises up to screening crests.**
- **Creating a tunneling effect.**
- **Maximizing the distance away from friendly howitzers.**
- **Cueing schedules based on the EW threat.**

FIREFINDER POSITION ANALYSIS SYSTEM (FFPAS)

- A computer program that facilitates the siting of AN/TPQ-36 and 37 Firefinder radars.
- Evaluates their ***probable detection performance*** from specific locations before they occupy the assigned position.
- May be used world-wide, provided digital terrain elevation data (DTED) is available.

THINGS FOR THE S3 TO REMEMBER

- **There is no such thing as a perfect radar position.**

- **<u>Have the radar tech conduct site recons.</u> Tell him where the target area is, not his search azimuth.**

- **S3/BDE FSO/FSCOORD/RADAR TECH must decide the best solution given the METT-T situation.**

- **Ensure Maneuver CDRs and FSOs understand how your decisions on radar positioning effects their current situation**

RADAR ZONES

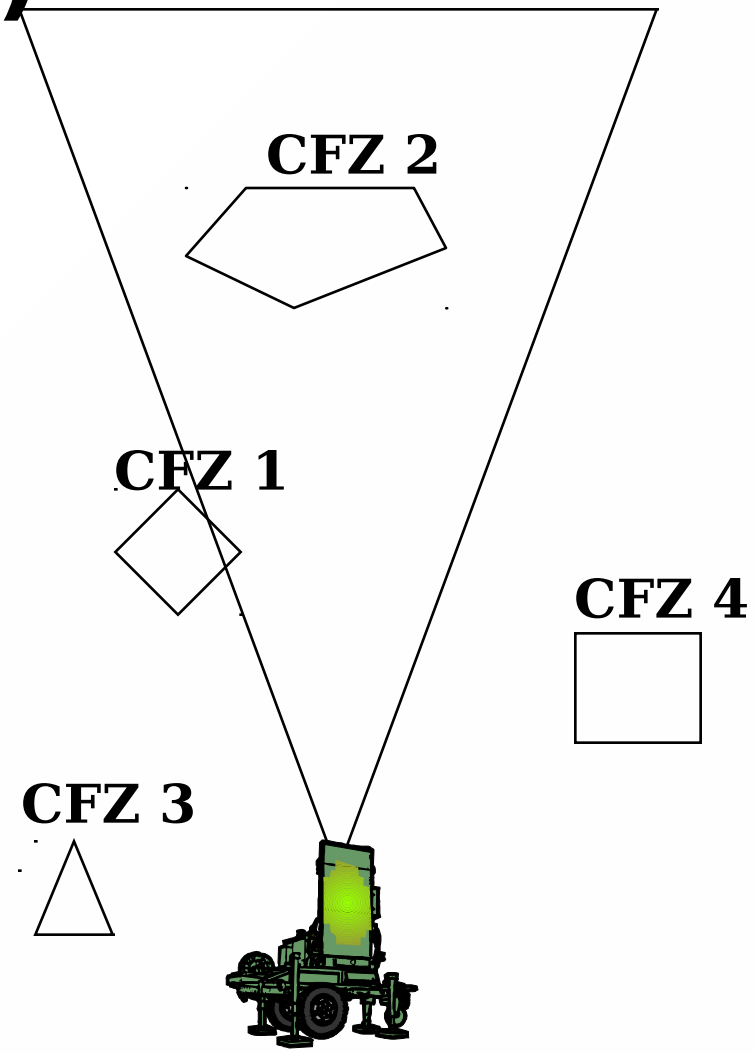
RADAR ZONES

There are four types :

- Critical friendly zone (CFZ)
- Call for fire zone (CFFZ)
- Artillery target intelligence zone (ATIZ)
- Censor zone (CZ)

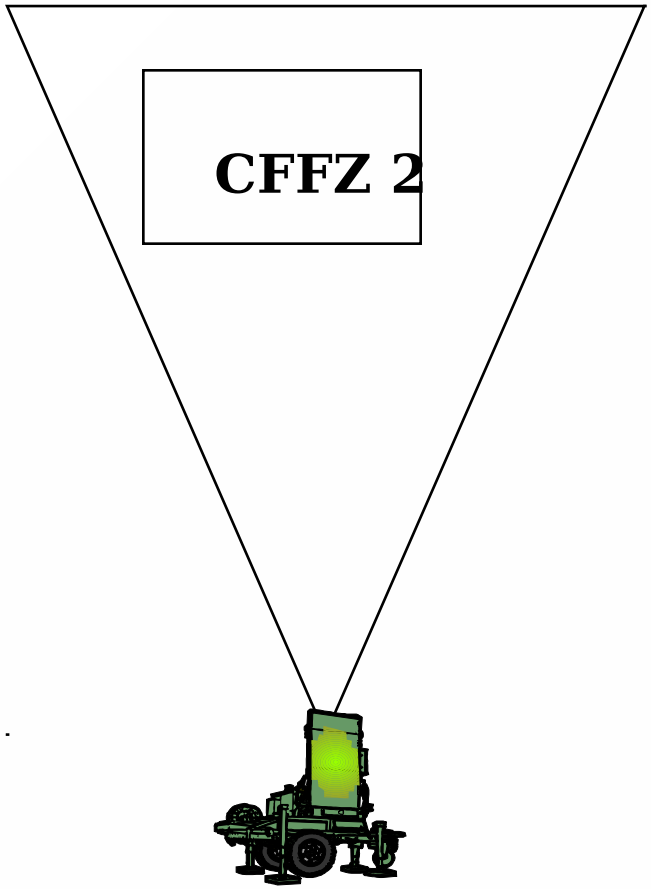
CRITICAL FRIENDLY ZONE (CFZ)

- **A friendly unit or location which the Maneuver Commander designates as critical to achieving the mission.**
- **A round impacting in this zone will result in a FM:CFF, priority one, being sent to the FDC.**
- **<u>Only point of origin is contained in the FM:CFF</u>**
- **Zone can be located outside the radar's search sector.**



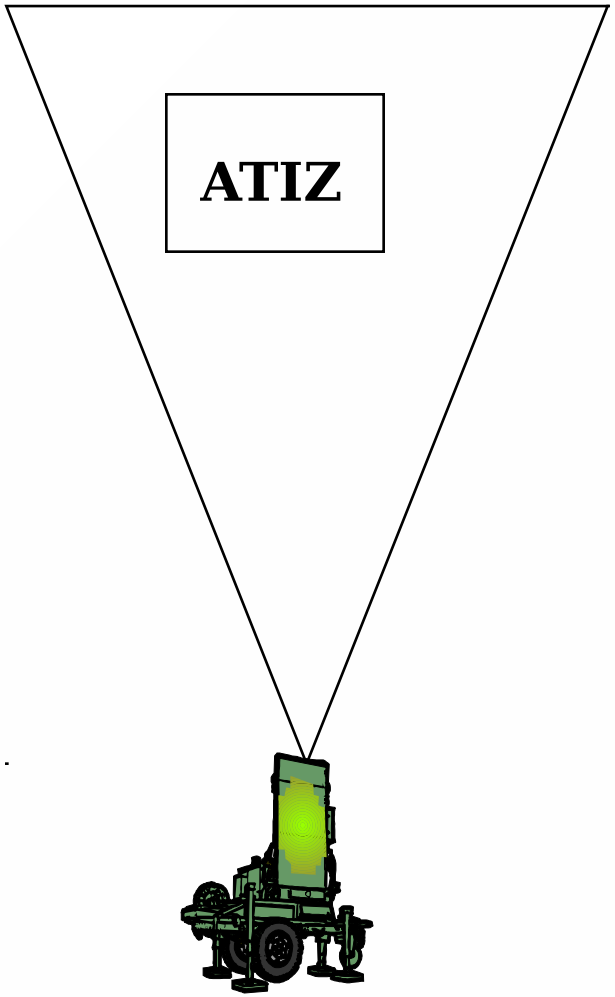
CALL FOR FIRE ZONE (CFFZ)

- **An area that considered a priority to identify/engage enemy indirect firing systems engaging friendly forces or effecting the area of operation.**
- **A weapon located in this zone will result in a FM:CFF, priority two, being sent to the FDC.**
- **<u>Only point of origin is contained in the FM:CFF</u>**
- **Zone must be located inside the radar's search sector**



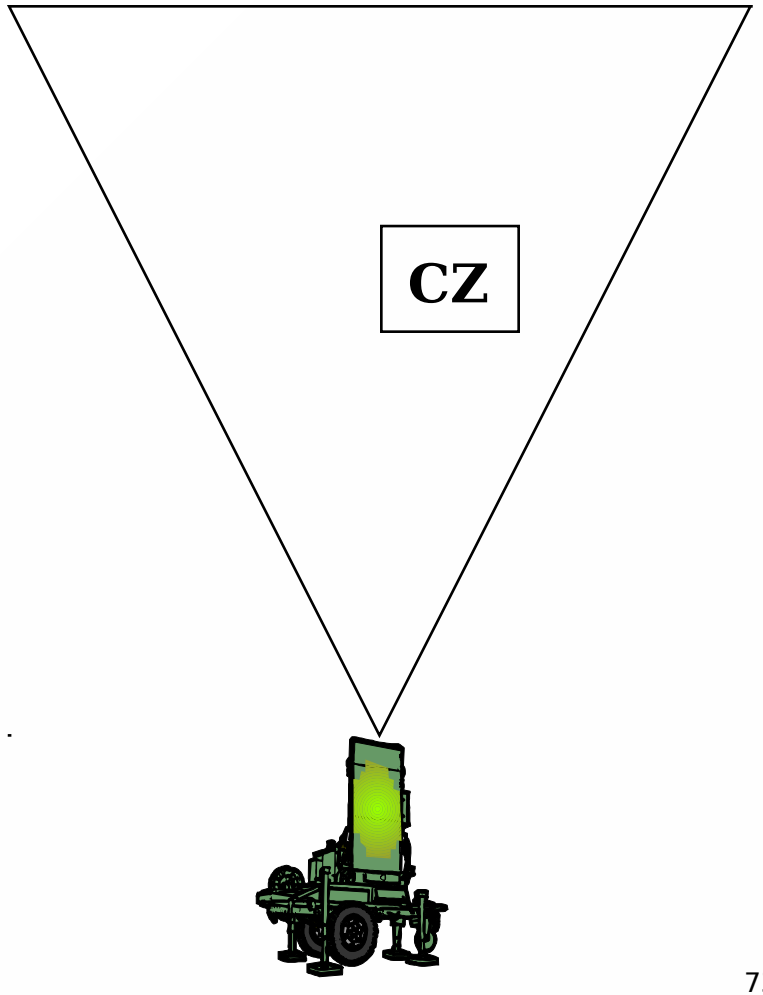
ARTILLERY TARGET INTELLIGENCE ZONE (ATIZ)

- **An area in that the Maneuver Commander wishes to closely monitor.**
- **A weapon located in this zone will result in an ATI:CDR being sent to the FDC.**
- **<u>Point of origin, point of impact, and suspected weapon type is contained in the ATI:CDR</u>**
- **Zone must be located inside the radar's search sector**



CENSOR ZONE (CZ)

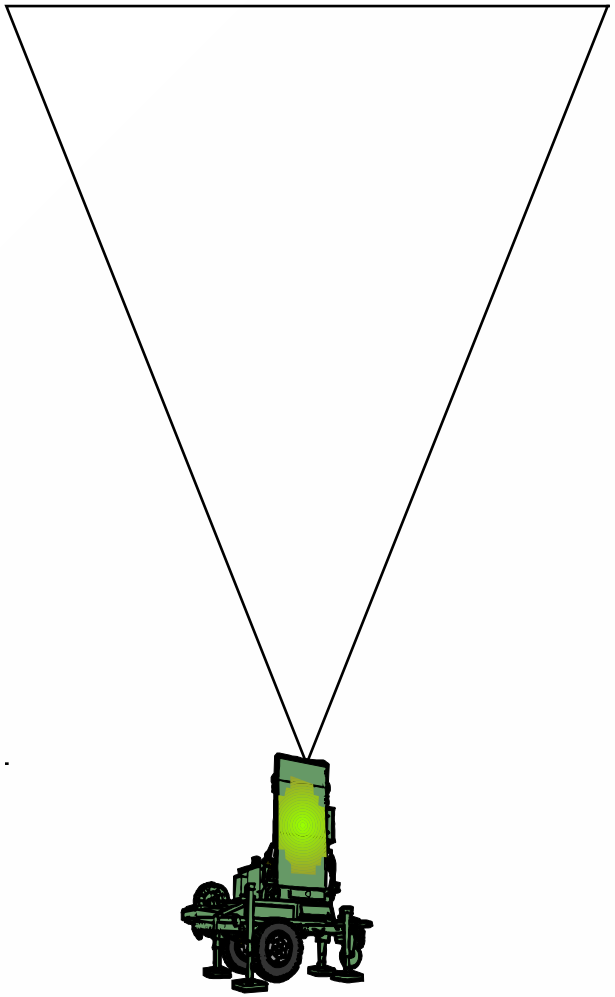
- **An area from which you wish to ignore all target detections.**
- ***<u>Weapons that fire from this zone are not processed by the radar.</u>***
- **Zone must be located inside the radar's search sector**



NO ZONES USED

- **A weapon located in the radar fan will result in an ATI:CDR being sent to the FDC.**

- **<u>Point of origin, point of impact, and suspected weapon type is contained in the ATI:CDR</u>**



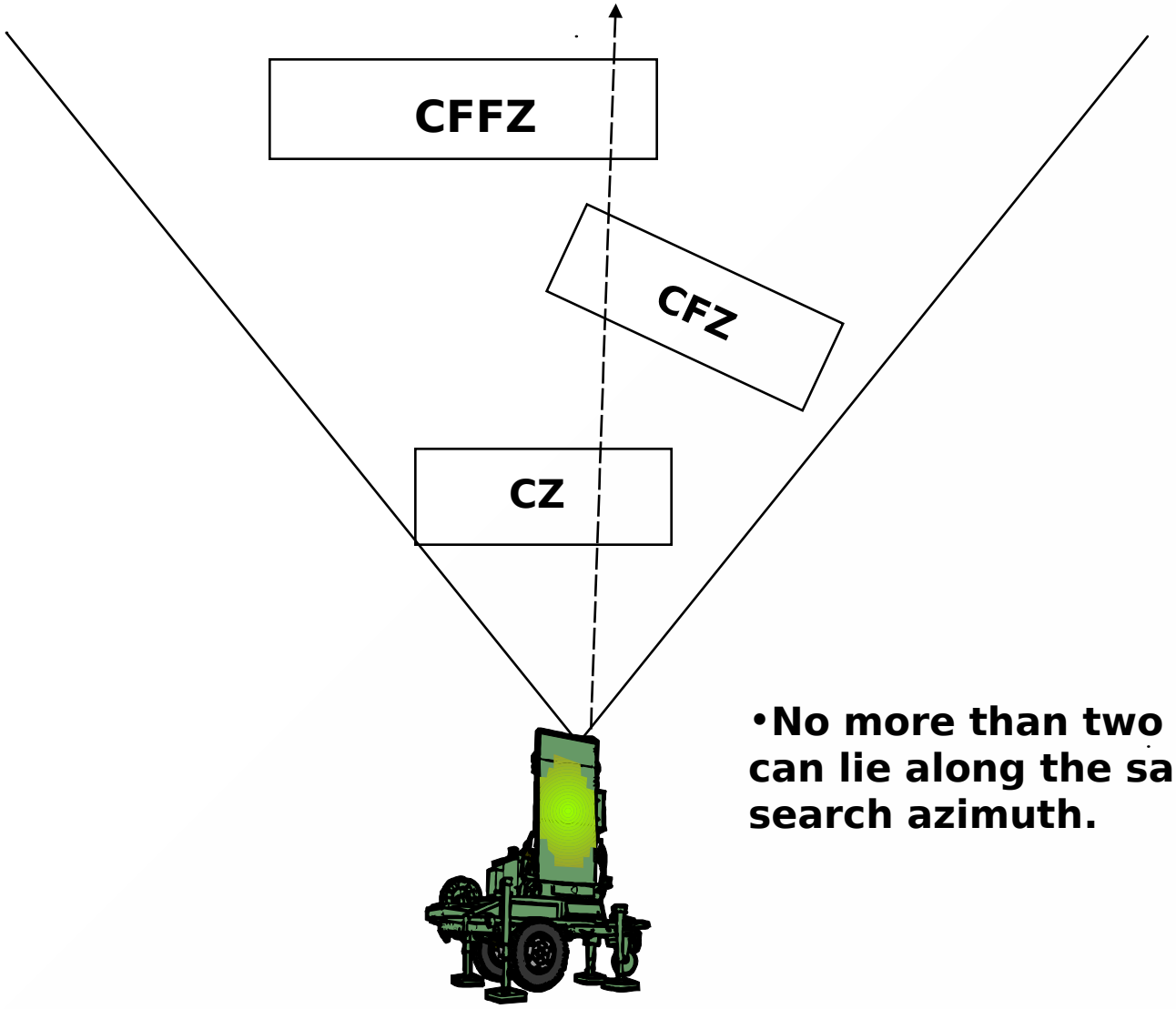
RADAR QUEUE PRIORITIZATION

- **Radar sorts target acquisitions in its target queue in priority of which zones the target violated:**
  - 1. CFZ
  - 2. CFFZ
  - 3. ATIZ
  - 4. NO ZONE

RADAR ZONE RULES

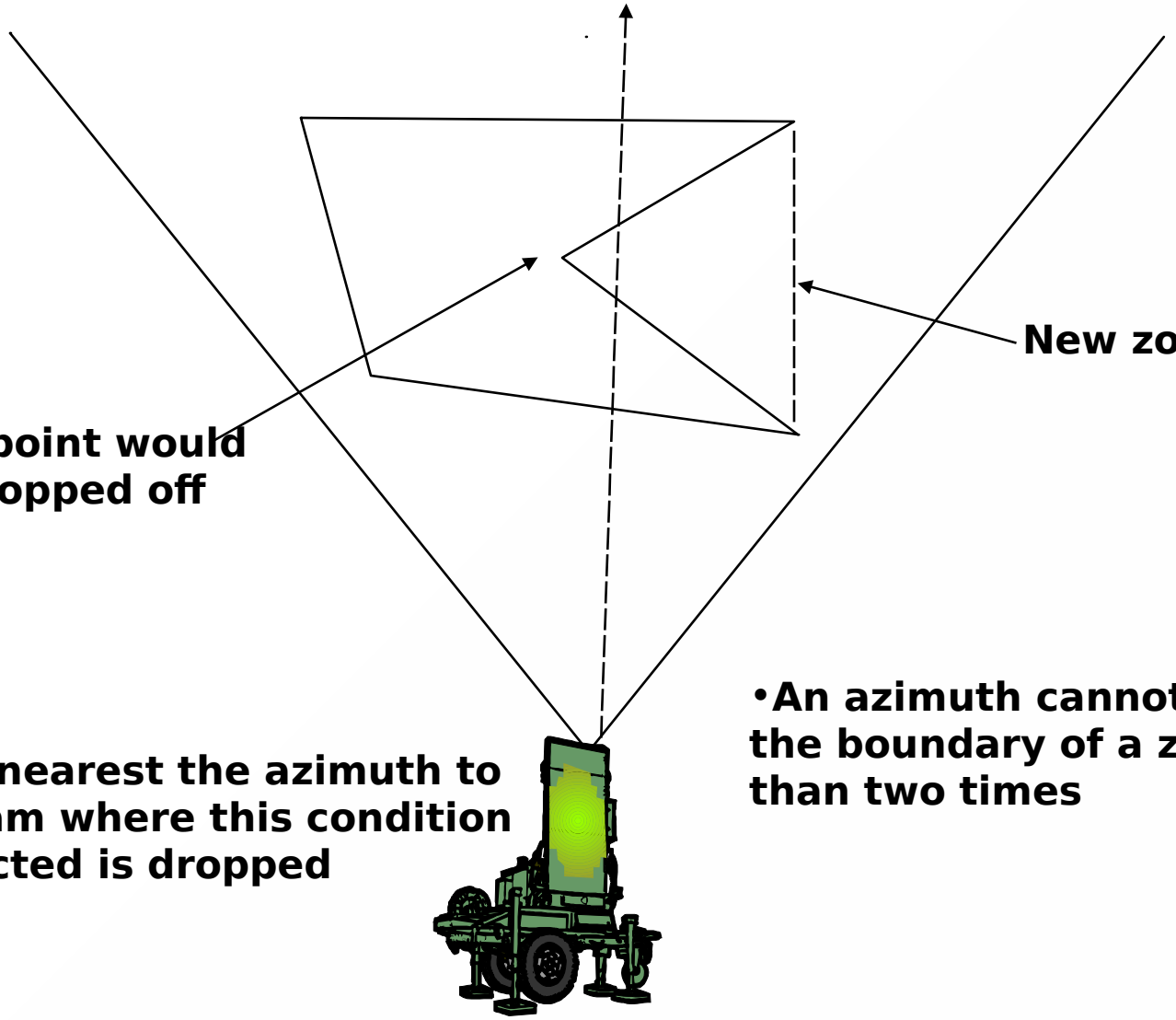
- **Up to nine zone can be entered into the radar. Zones can be of one type or any combination of zones.**
- **A zone is defined by a minimum of 3 grids, a maximum of 6 grids.**
- **Radar zones cannot intersect or touch each other**
- **No more than two zones can lie along the same search azimuth.**
- **Grid coordinates must be entered sequentially (Clockwise or counter-clockwise)**
- **All zones, except CFZs, must fall within the radar search sector.**
- **An azimuth cannot intersect the boundary of a zone more than two times.**

EXAMPLE OF ZONE REJECTION



- No more than two zones can lie along the same search azimuth.

EXAMPLE OF ZONE REJECTION



Vertex nearest the azimuth to the beam where this condition is detected is dropped

•An azimuth cannot intersect the boundary of a zone more than two times

ZONE MANAGEMENT

- **Who is the zone manager? Who decides what zones go where? Who decides how many of what type of zones to use? Who tracks the zones?**
  - **TTP: BDE FSO = CFZs, Counterfire HQ/ S2 = CFFZ, CZ, & ATIZ**

- **Zone manager directs radar tech which zones to delete and which zones to add or change.**

- **If a 10th zone is entered into the radar the 1st zone is automatically rejected.**
  - **TTP: Delete old zone before entering a new zone.**

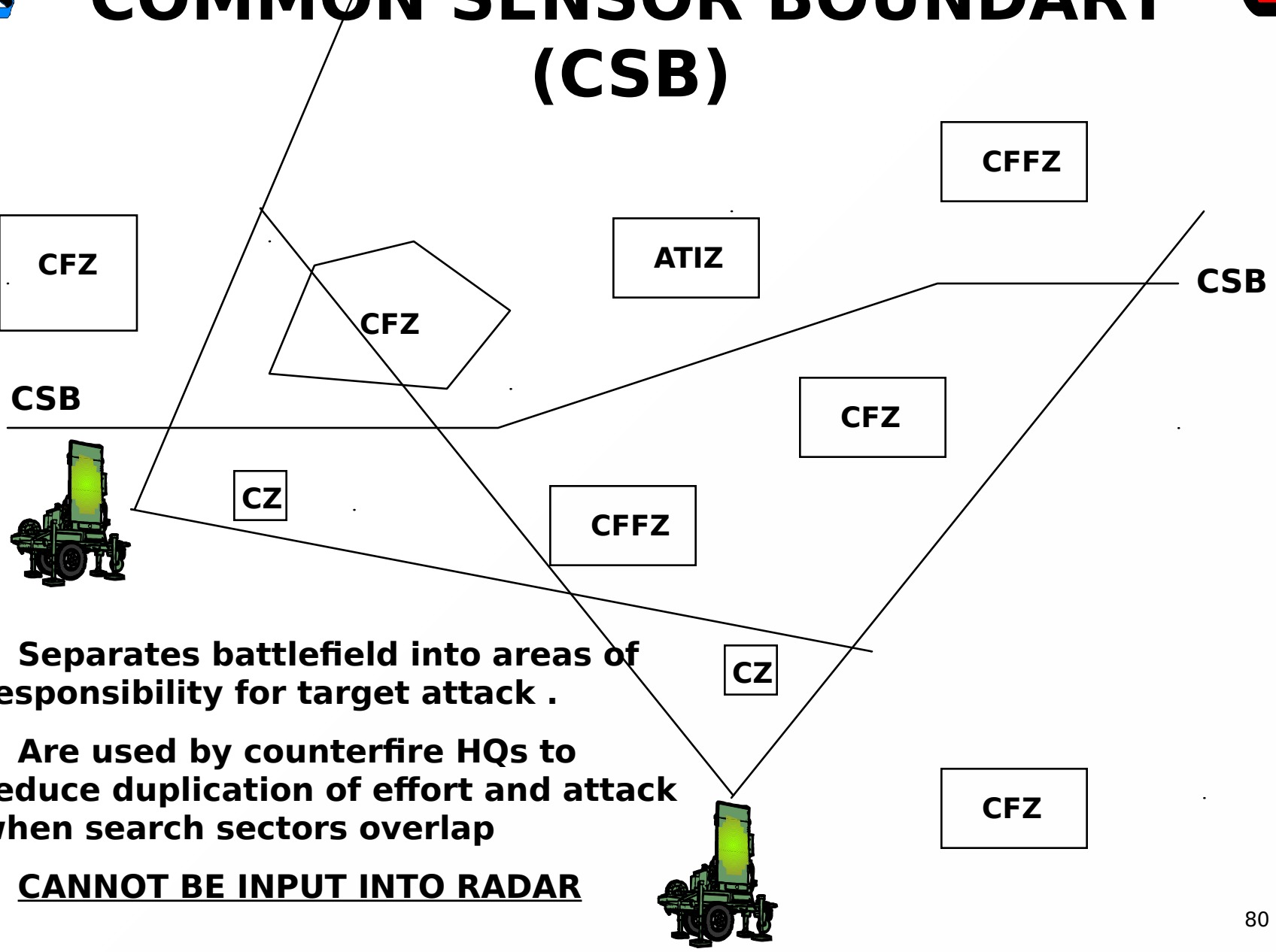
- **Zones and search sectors can be digitally submitted to the radar using SPRT:SEARCH and SPRT:FILTER messages.**

- **If changing zones via digital traffic always confirm via voice.**

- **Radar Deployment Order is used to establish zones.**

- **Consider using a zone execution matrix rather than RDO to execute**

COMMON SENSOR BOUNDARY (CSB)



- **Separates battlefield into areas of responsibility for target attack .**
- **Are used by counterfire HQs to reduce duplication of effort and attack when search sectors overlap**
- **<u>CANNOT BE INPUT INTO RADAR</u>**

COMMON SENSOR BOUNDARY ESTABLISHMENT CONSIDERATIONS

- **Range of attack weapons**
- **Available attack assets**
- **Effective range of target acquisition assets**
- **Predicted enemy indirect fire weapon deployment areas**
- **Availability of ammunition**

COMMON CENSOR BOUNDARY USE CONSIDERATIONS

- **CSBs <u>cannot</u> be entered into the radar's computer, it is a manual C2 graphic ONLY.**
- **CSB does not effect radars ability to track targets. Radar will locate targets beyond and short of CSB.**
- **Radar operator sends ALL acquisitions to FDC/TOC regardless of CSB location!**
- **TOC passes targets outside it's area of responsibility to the responsible HQs.**
- **TOC takes action on targets inside it's area of responsibility.**
- **Who is the CSB manager?**

OTHER RADAR STUFF THE FIELD GRADES NEEDS TO KNOW

AUTO CENZORING

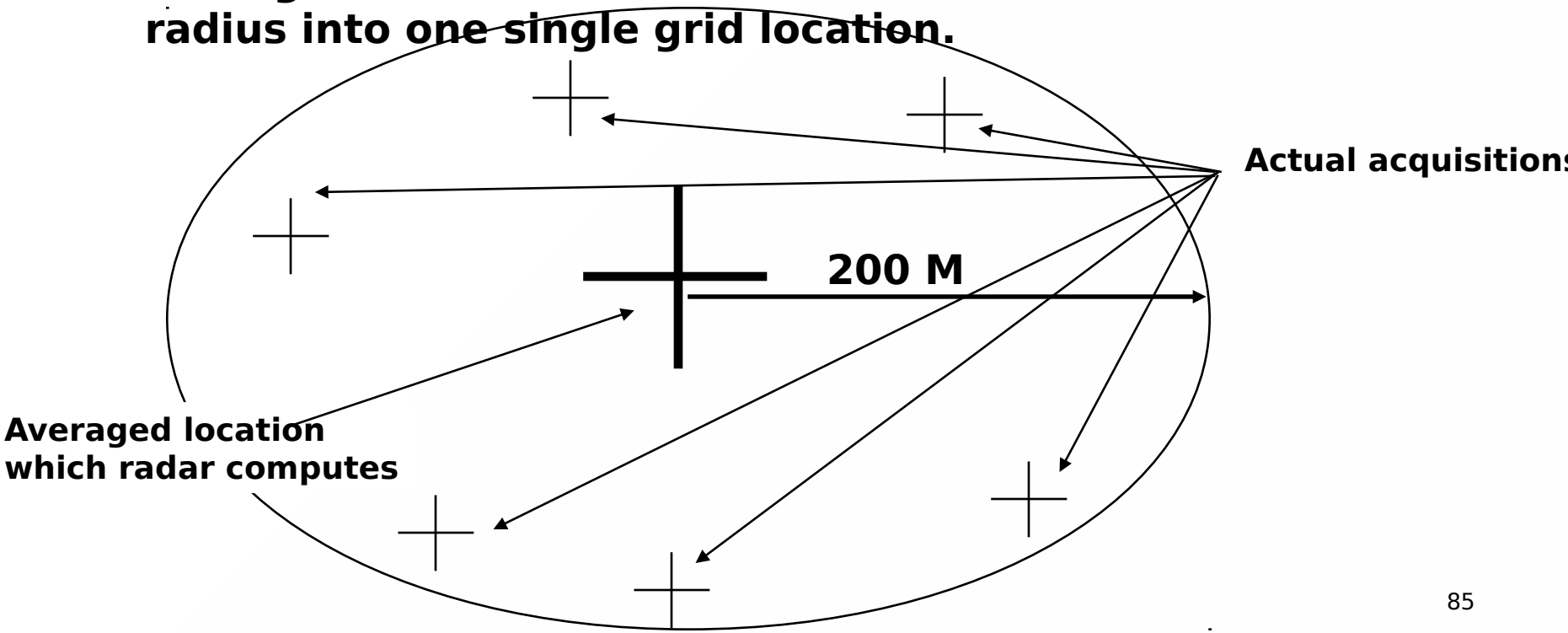
- **Purpose: To prevent tracking the same weapon numerous times.**
- **When this function is enabled, the radar to ignores acquisitions which originate from the same location after the designated number of tracks are detected.**
- **Specified number of tracks = Operator selects 2 to 16.**
- **Size of area = 500 meters**

e.g.: If censoring is enabled, and the operator specifies 3 tracks, the radar will ignore every acquisition, after the third track, which originates out of the same 500 meter area.

LOCATION AVERAGING

- **Purpose: To prevent overloading the radar's storage queue with acquisitions from the same location.**

- **When location averaging is turned on, the radar averages all detections from the same 238 meter radius into one single grid location.**



VOLLEY ACQUISITIONS

- **Purpose: Combines acquisitions, detected from rounds fired in a volley from the same location at the same time, into a single target.**

- **Parameters:**

  - **Rounds must break the search fence within 0-2 seconds of each other.**
  - **Rounds must be located a maximum of 30 meters from each other.**
  - **Combines 2 to 6 tracks fired from the same location**

- **Radar queues the operator as to weather the acquisition is from a volley or single type of detection**

WHAT HAPPENS INSIDE THE SHELTER?

0 SECONDS →

- Projectile breaks the search fence
- Radar detects, verifies, and tracks projectile
- Radar determines solution

6 SECONDS →

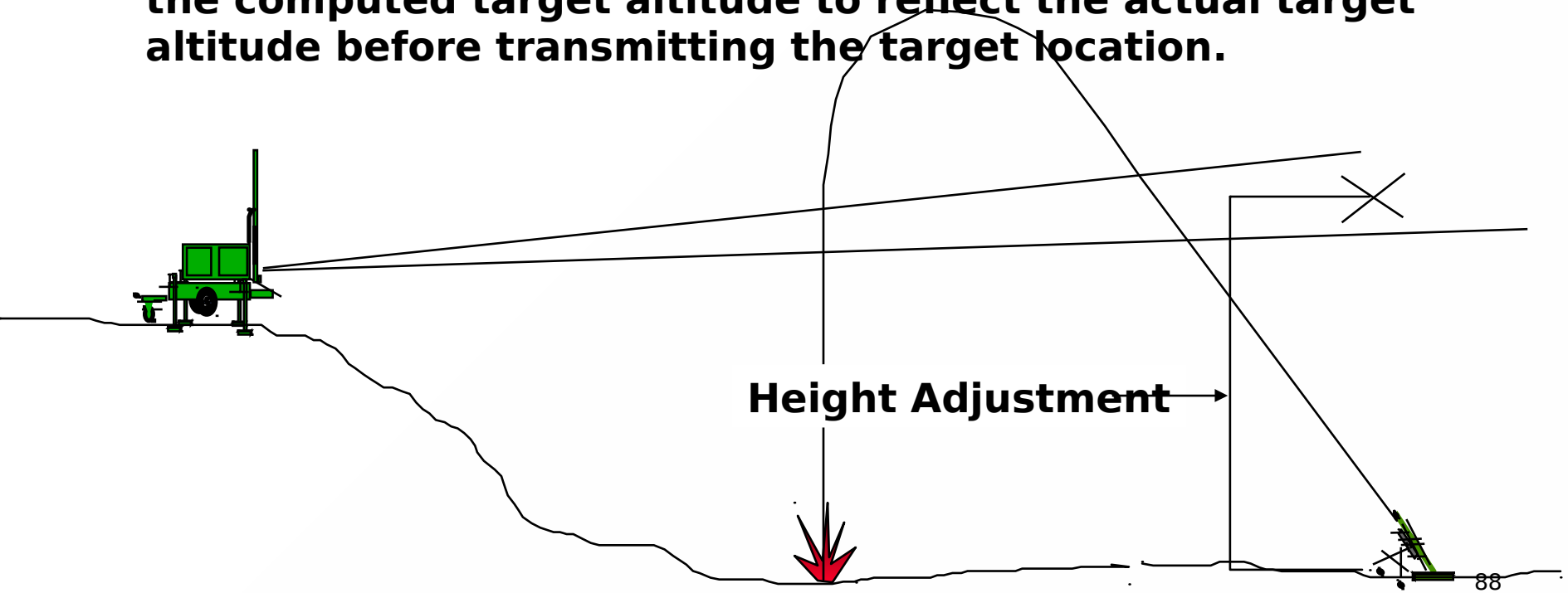
- Alarm notifies operator of detection
- Bug light plots target origin on map
- Operator height adjusts (if not using digital map)
- Operator depresses tacfire compute button

22 SECONDS →

- Operator transmits detection to FDC

WHAT IS HEIGHT ADJUSTMENT?

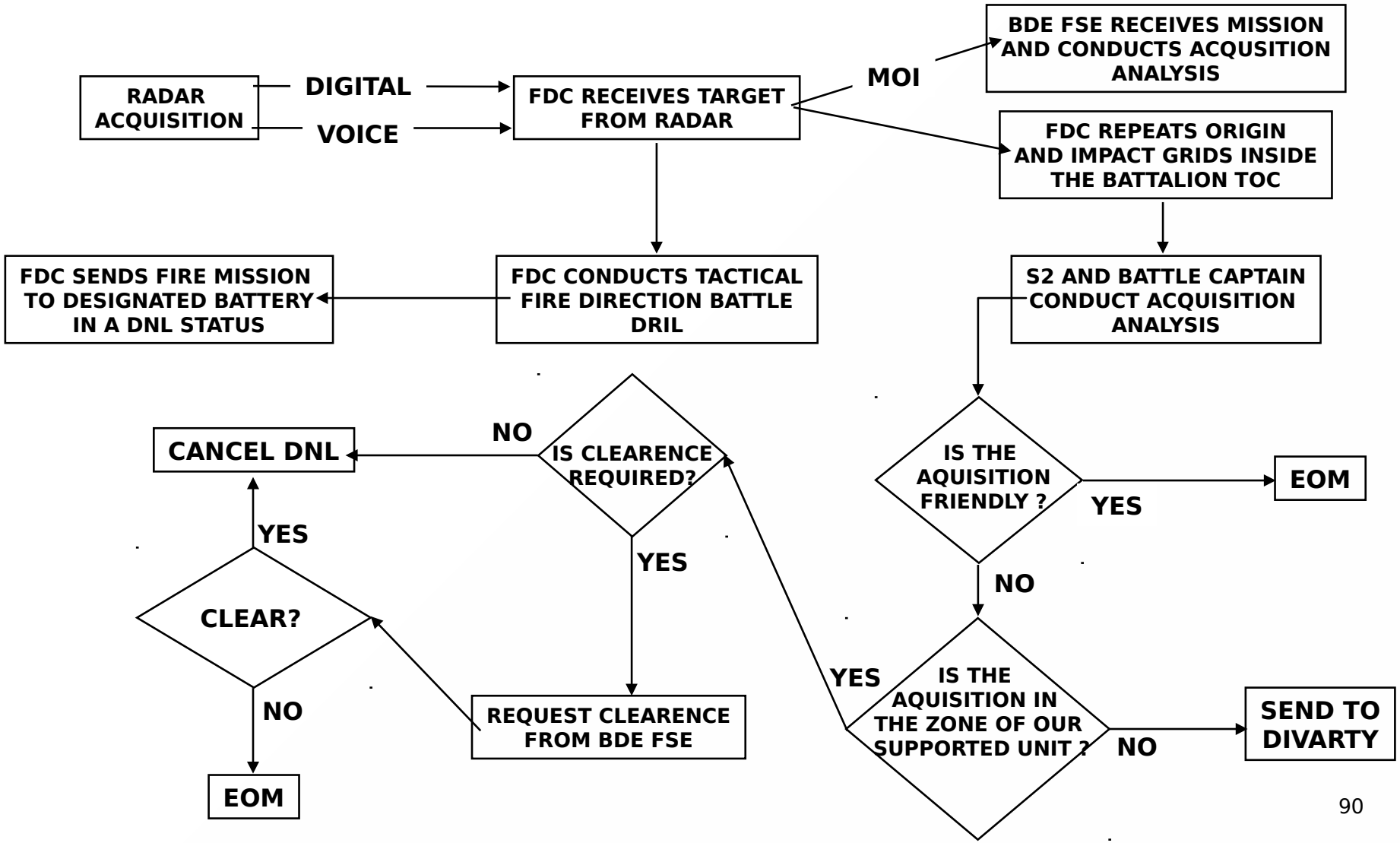
- **If the radar is not using a digital map, then:**
- **Radar thinks target altitude is the same as the radar altitude.**
- **Operator must look at the map and manually adjust the computed target altitude to reflect the actual target altitude before transmitting the target location.**



TOC COUNTERFIRE DRILL

- **Is the target friendly, enemy, neutral, or false?**
- **Do we want to shoot it?**
- **Who’s zone / sector is the target in?**
- **Do we need to clear it?**
- **What is your TOC’s counterfire battle drill?**

EXAMPLE TOC COUNTERFIRE BATTLE DRILL



HOW FAST CAN THE FIRE SUPPORT SYSTEM PROCESS A COUNTERFIRE MISSION?

- **Radar can track five to six rounds simultaneously**
- **Radar can store up to 10 target locations for processing (in queue)**
- **A good radar operator can process 2-3 targets a minute**
- **FDC/TOC/FSE can process and clear a mission in ? minutes**
- **Guns can load and fire a mission in ? minutes**

CUEING

- **Continuous**
  - EW threat must be low or non-existent
  - Radar must have maintenance “down” time
- **Situational** (pro-active)
  - Ties cueing to events / triggers
  - EW threat exists
- **On Demand** (reactive)
  - In response to enemy action
  - Must establish cueing agents and cueing guidance
  - EW threat exists
- **Combination of situational and on-demand**

COMMUNICATIONS

- **Radar section is authorized three radios**
  - **Two in shelter**
  - **One in recon vehicle**

- **Radar typically monitors two nets**
  - **Digital FD net**
  - **Voice command net**

- **Radar is only capable of sending digital communications to one subscriber at a time (can store up to 10 subscribers). Can receive from any digital subscriber.**

MET

- **Radar needs computer MET messages!**
- **Radar uses computer MET to refine wepon locations by adjusting for the effects of wind.**
- **Winds less than 20 knots have little effect on the projectile extrapolation.**
- **Is the computer MET message you give to the radar valid for the probable location of enemy indirect fire system?**

FREINDLY FIRE MODE

FRIENDLY FIRE MODE

- **Radar registrations and radar adjustment missions.**

- **Six (6) Modes:**
  - **Mortar air burst**
  - **Mortar datum plane registration**
  - **Mortar impact prediction**
  - **Artillery air burst**
  - **Artillery datum plane registration**
  - **Artillery impact prediction**

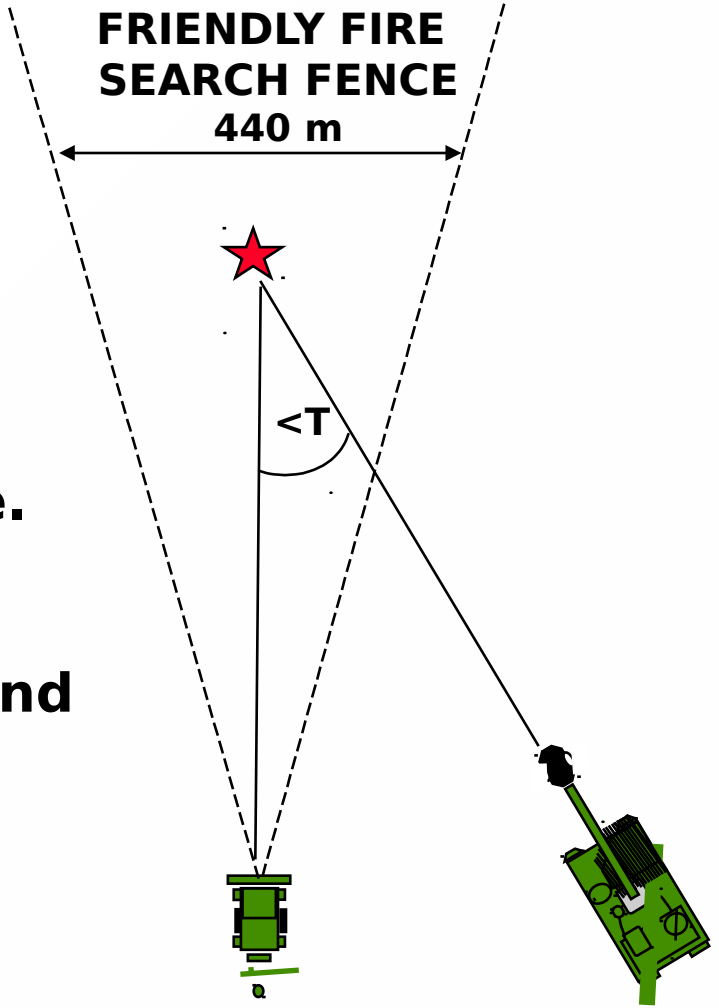
- **<u>No rocket mode (MLRS)</u>**

FREINDLY FIRE MODE

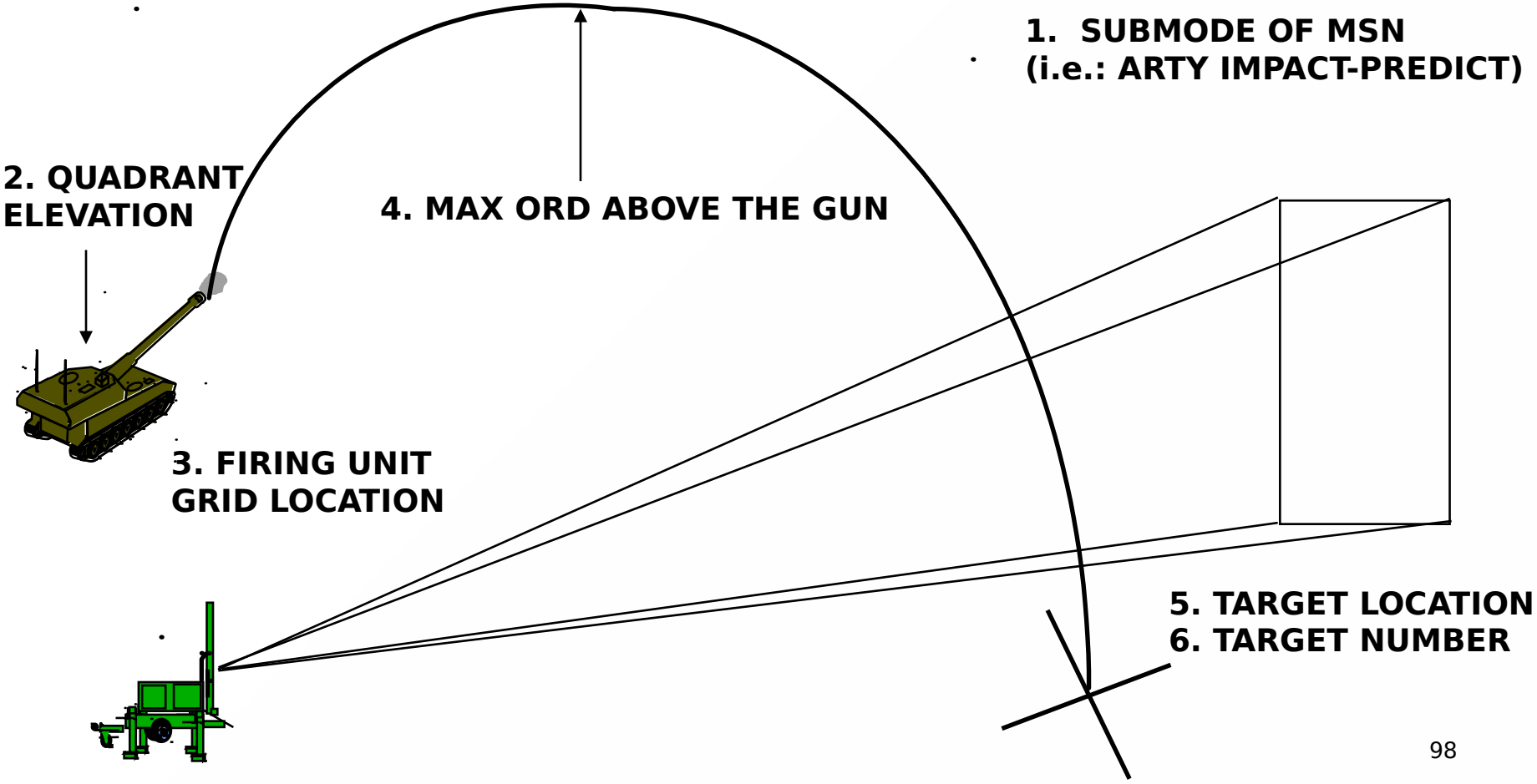
- **FF mode has the same range limitations and probabilities of detection as in the hostile mode.**

- **FF search fence is focused to 440 mils, through which the round must pass**

- **The optimum radar angle-T is 400 mils with acceptable angles from 0800 mils to 1200mils.**



FRIENDLY FIRE MODE INFORMATION REQUIREMENTS



FIELD EXERCISE MODE (FEM)

- **Simulates hostile and friendly fire modes without radiating.**
- **Target Processing and communicate with the LTTACFIRE / IFSAS / AFATDS systems.**
- **One hundred simulated targets with the AN/TPQ-36 and one hundred and fifty (150) simulated targets with AN/TPQ-37.**
- **Jamming scenario (Meaconing, intrusion, jamming and interference / MIJI report).**

LESSONS LEARNED FROM RECENT DEPLOYMENTS

- **Bosnia:**
  - 24 hours Operations
    - Maintenance Program
    - Manning Issues
  - Monitor Zone of Separation (ZOS)
  - Firefinder Position Analysis System (FFPAS) used daily.

- **Somalia:**
  - High False Location Rate primarily caused by helicopters.
  - Emphasis on impact predict to assist in the locating of DUD munitions.
  - Non-standard indirect weapon system employment techniques